

University of Cambridge
School of Agriculture Memoirs

Memoir No. 26

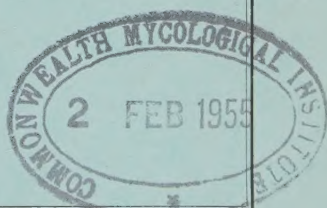
A summary of the papers published by the members of the Staff of the School of Agriculture and its Associated Research Organisations during the period Oct. 1st, 1953—Sept. 30th, 1954.

Review Series

No. 9. The Cambridge University
Farm



CAMBRIDGE
1955



FOREWORD

This Memoir, which is published under the general editorship of the Librarian of the School, represents an attempt to present as succinctly as possible the contributions made by members of the Staffs of the School of Agriculture and its Associated Research Organisations to the development and progress of Agricultural Science, to indicate to research workers interested the Journals in which the full papers are presented and to act as a complete record of papers published. Each summary is compiled by the author of the paper and is presented, so far as the subject matter will allow, in a non-technical form in order to be of value to the general body of farmers interested in the more recent developments of agricultural scientific research in general and of the activities of this Department in particular.

Requests for further information or criticism arising out of the summaries should be referred to the individual author concerned; criticisms and suggestions for the improvement of the Memoir itself should be addressed to the Librarian of the School.

The Librarian takes this opportunity of thanking all Institutions etc. who have kindly sent literature during the past year.

Correspondence relating to the Memoir and Publications sent in exchange should be addressed to :

THE LIBRARIAN,
SCHOOL OF AGRICULTURE,
UNIVERSITY OF CAMBRIDGE,
CAMBRIDGE,
ENGLAND. (TEL. NO. CAMBRIDGE, 2485, Ext. 17).

**University of Cambridge
School of Agriculture Memoirs**

Memoir No. 26

A summary of the papers published by the members of the Staff of the School of Agriculture and its Associated Research Organisations during the period Oct. 1st, 1953—Sept. 30th, 1954.

Review Series

No. 9. The Cambridge University
Farm

CONTENTS

	PAGE
STAFF - - - - -	3
CAMBRIDGE UNIVERSITY FARM, by W. S. Mansfield - - -	5
SUMMARIES - - - - -	11
Agricultural Economics - - - - -	11
Agriculture - - - - -	12
Animal Breeding and Genetics - - - - -	13
Animal Nutrition - - - - -	13
Animal Pathology - - - - -	15
Animal Physiology - - - - -	15
Animal Production - - - - -	19
Crop Pests and Diseases - - - - -	20
Plant Breeding and Genetics - - - - -	22
Soil Science - - - - -	23
Statistics - - - - -	24
Miscellaneous - - - - -	24
Books Received - - - - -	25
Library Lacunae - - - - -	26
Author Index - - - - -	<i>inside back cover</i>
Publications - - - - -	<i>back cover</i>

FACULTY OF AGRICULTURE

I. GRADUATE STAFF

DRAPERS PROFESSOR OF AGRICULTURE

SIR F. L. ENGLEDDOW, C.M.G., M.A., F.R.S. (*Joh.*)

EMERITUS READER

J. HAMMOND, C.B.E., M.A., F.R.S. (*Down.*), Agricultural Zoology and Physiology.

READERS

F. HANLEY, O.B.E., M.A. (*Joh.*), Crop Husbandry.

H. H. NICHOLSON, M.B.E., M.A. (*Selw.*), Soil Science.

J. WISHART, M.A., D.Sc. (*Lond.*), (*Clare*), Statistics.

H. E. WOODMAN, M.A., Ph.D. (*Göth.*), D.Sc. (*Leeds*), (*Down.*), Animal Nutrition.

UNIVERSITY LECTURERS

M. G. BARKER, M.A. (*Trin.*), Agricultural Implements and Machinery.

A. J. BROOKES, M.A. (*Selw.*), Agriculture.

S. DICKINSON, M.A., M.Sc. (*Wales*), (*Emm.*), Plant Pathology.

R. E. EVANS, Ph.D. (*Caius*), Animal Nutrition.

D. G. GILMOUR, Ph.D. (*Cath.*), Agricultural Zoology and Physiology.

F. G. W. JONES, M.A. (*Jesus*), Agricultural Entomology.

R. LEACH (*Emm.*), M.A. (*Oxon.*), A.I.C.T.A., Agricultural Mycology.

J. LINE, M.A. (*Emm.*), Agricultural Botany.

MISS E. H. WHETHAM, M.A. (*Newnham*), Gilbey Lecturer in the History and Economics of Agriculture.

ASSISTANT DIRECTOR OF RESEARCH

E. C. CHILDS, Sc.D. (*Clare*), Soil Physics.

UNIVERSITY DEMONSTRATORS

A. W. COLLING, M.A., Agricultural Entomology.

R. J. HALLEY, B.Sc. (*Agric.*), Dip. Dairy Husbandry (*Reading*), Agriculture.

F. A. HOLTON, Ph.D. (*Trin.*), Animal Nutrition.

D. E. G. IRVINE, Ph.D. (*St. Andrews*), Agricultural Botany.

K. E. KIRKHAM, M.A. (*Fitzw.*), Animal Physiology.

A. LAZENBY, M.A., M.Sc. (*Wales*), Agricultural Botany.

D. M. McALEESE, B.Sc., B.A.G. (*Queen's, Belfast*), Soil Science.

R. M. S. PERRIN, M.A. (*King's*), Soil Chemistry.

W. J. RIDGMAN, M.A. (*Queens'*), Agriculture.

J. D. WHITEAR, M.A., Agriculture.

ASSOCIATE LECTURER

F. G. STURROCK, M.A. (*Trin.*), Agricultural Economics.

OTHER LECTURERS

H. I. FIELD, M.Sc. (*Wales*), M.R.C.V.S., Animal Hygiene.

E. A. GIBSON, B.Sc. (*Lond.*), M.R.C.V.S., Animal Hygiene.

E. T. HALNAN, M.A. (*Trin.*), Agricultural Zoology and Physiology.

J. HAMMOND, C.B.E., M.A., F.R.S. (*Down.*), Agricultural Zoology and Physiology.

E. LAWRENCE, O.B.E. (*Fitzw.*), Tropical Agriculture.

M. S. PEASE, M.A. (*Trin.*), Animal Genetics.

ASSISTANTS IN RESEARCH

M. G. BRUSH, B.Sc. (*Edin.*), Animal Physiology.

J. A. PALMER, M.A., Agricultural Engineering.

H. T. TRIBE, Ph.D. (*Lond.*), Soil Microbiology.

DIRECTOR OF ADVANCED STUDENTS

F. HANLEY, O.B.E., M.A. (*Joh.*).

THE UNIVERSITY FARM

W. S. MANSFIELD, C.B.E., M.A. (*Emm.*), Director.

J. HODGES, B.Sc. (*Reading*), Farm Demonstrator.

R. H. JARVIS, B.A. (*Down.*), Farm Demonstrator.

SECRETARY

G. G. KERR, M.A. (*Trin.*).

II. STAFFS OF THE RESEARCH ORGANISATIONS ATTACHED TO THE SCHOOL OF AGRICULTURE

POULTRY GENETICS STATION

M. S. PEASE, M.A. (*Trin.*), Director.
A. G. COCK, M.A. (*Corpus*).

PROVINCIAL AGRICULTURAL ECONOMICS SERVICE

F. G. STURROCK, M.A. (*Trin.*), Provincial Agricultural Economist.
C. S. BARNARD, M.A. (*Queens'*).
G. H. BRAYSHAW, M.A. (*Clare*).
G. B. CLARKE, (*Cath.*), B.Sc. (Econ.), (*Lond.*).
D. FISCHER, B.Sc. (*W. Australia*).
P. E. GRAVES, M.B.E.
MISS J. HUMBERSTONE, Dip. Agric. Econ. (*Oxon.*), B.Sc. (Agric.), (*Nottingham*).
R. A. MACKNESS, M.A. (*Joh.*).
P. E. NAYLOR, B.A., Dip.Ag.Sci. (*Pemb.*).
J. S. NIX, M.A. (*Joh.*).
D. B. WALLACE, M.A. (*Queens'*).

SOIL PHYSICS UNIT

E. C. CHILDS, Sc.D. (*Clare*), Director.
N. COLLIS-GEORGE, Ph.D. (*Fitzw.*), M.Sc. (*Manchester*).
E. G. YOUNGS, B.Sc. (*Lond.*).

OTHER RESEARCH STAFF

R. A. DUNNING, Ph.D. (*Queens'*), Sugar Beet Pests.
A. N. EDE, B.A. (*Cath.*), Drainage Engineering.
N. E. RIDER, B.Sc. (*Lond.*) (*Seconded from the Meteorological Office*), Meteorology.
MISS A. M. SHEPHERD, B.Sc. (*Lond.*), Sugar Beet Pests.
H. R. WALLACE, Ph.D. (*Liverpool*), Sugar Beet Pests.
T. D. WILLIAMS, B.A. (*Oxon.*), Potato Root Eelworm.
R. D. WINSLOW, Ph.D. (*Jes.*), Sugar Beet Pests.

COMMONWEALTH BUREAU OF PLANT BREEDING AND GENETICS

P. S. HUDSON, Ph.D. (*Trin.H.*), Director.
R. H. RICHENS, M.A. (*Selw.*), Assistant Director.
MISS T. ASHTON, M.A. (*Girton*).
MISS M. L. C. WILSON, Sen.Mod. B.A. (T.C.D.).
B. HEISELER.
MISS O. HOLBECK, B.Sc. (*Lond.*).
A. H. WELSH, M.A. (*Oxon.*).

III. DEPARTMENTAL LIBRARY

LIBRARIAN

F. A. BUTTRESS.

THE CAMBRIDGE UNIVERSITY FARM*

By

W. S. MANSFIELD, C.B.E., M.A.

(*Director of the University Farm*)

It was not long after the time when formal teaching in Agriculture first began in the University of Cambridge that a University Farm was established. This was in the year 1900 when Burgoynes Farm, situated in the parish of Impington, some three miles from Cambridge was leased from a private owner. Burgoynes was a small farm of some 142 acres nearly all of it being under the plough. Inherently it was a really good farm though in a poor state of cultivation when the University took possession, the soil being a fertile gravel loam admirably suited to the growing of almost all crops. The land was well drained with an adequate lime content and the fields were large, level and regular in shape.

It seems certain that the main purpose the Department of Agriculture had in mind in establishing the farm was to provide facilities for field experimentation in crop husbandry. No doubt it was anticipated that as an experimental farm it would also be of value for teaching purposes, but clearly the emphasis was upon experimentation, and, for field experiments as they were then carried out, the farm was ideal. In those days there was no elaborate technique of field experimentation, or no statistical layouts and treatment of results. The various treatments were tested one against another in large plots often an acre or more in area arranged in order and sometimes not even replicated. If the results were to have any significance it was clearly necessary that the soil of the experimental fields should be reasonably uniform, and no doubt it was also considered a great advantage that the land being inherently fertile, good crops could be grown with a high degree of certainty. For it must be remembered that agricultural science in those days was gravely suspect, and by none more than by farmers and any sort of crop failure presented a golden opportunity for destructive criticism. Incidentally this is possibly the reason why nearly all the early Agricultural College farms were situated on good land. No doubt good land makes life easier for those who are responsible for managing it, and if the farms are used only for experimental purposes there may be something to be said in its favour, but if they are to be used for teaching purposes then it is definitely a disadvantage, as it leads young men to believe that farming is a great deal easier than in fact it is.

The farming of Burgoynes Farm presented no great problems. The land was good, labour was cheap and plentiful and the capital required for stocking and running such a farm in those days was small. Experiments which involved a great deal of hand labour could be planned and undertaken at small expense. Undoubtedly the most important work carried out on the farm was the plant breeding of Biffen. It was here that the first of the improved wheat varieties, Little Joss, was bred, a variety that quickly became popular and was extensively grown in the Eastern Counties for many years. It was on this farm too that Middleton carried out some of his pioneer work on seeds mixtures. But in 1910 the lease of this farm ran out and could not be renewed and the University had to look elsewhere to find a suitable farm.

The farm eventually selected was Gravel Hill Farm situated within the Cambridge City boundary on the Huntingdon Road, and owned by Trinity College. Like Burgoynes the farm was in a very poor state of cultivation when it was hired by the University, but unlike Burgoynes it was not comprised of inherently fertile land. It had, however, two great advantages from the point of view of teaching, its proximity to the centre of Cambridge and the fact that it included two completely different types of soil, for by this time with a growing number of young men reading agriculture the provision of teaching facilities was becoming more and more important.

A farm which is attached to an educational institution presents special difficulties. On the one hand it must provide varied facilities for teaching and experimental work, and profits must often be sacrificed to these ends. On the other hand it is not enough to provide a miscellaneous collection of material for demonstration; the main purpose of the farm—at least in the opinion of those responsible for the teaching of Agriculture at Cambridge—must be to provide an object lesson in management, and the object lesson will be valueless if the farm is run at a continuous financial loss. It has sometimes been argued that no single farm can serve the two purposes and that a choice must be made between them. The Cambridge University Farm is an attempt at a compromise, though its function as a teaching farm is always the first consideration and its management is designed with this end in view. It must be admitted that the other functions which the farm is called upon to fulfil complicate matters considerably, making commercial efficiency difficult of attainment, yet the teaching value of the farm (which in no small degree depends upon its financial success) is never forgotten.

But at Cambridge there is a large and important post graduate school the requirements of whose members have to be catered for as well as the requirements of those who are reading for a first degree, and instruction in the various techniques of field experimentation forms a very important part of their curriculum. A good deal of experimental work has therefore to be carried on with both crops and livestock. As far as possible the policy is to make use of the crops and stock ordinarily grown on the farm. This means not only a great saving in money, but ensures that the conditions under which the experiments are carried out are not in any way artificial. Results thus obtained may be regarded with considerable confidence as being those likely to be obtained under normal farming conditions. The subjects which are at present under investigation include drainage problems, the effect of various kinds of cultivation, placement of fertilisers, and a long term experiment on a heavy clay field comparing rotations containing three year or six year leys and three year or six year arable cropping in all combinations. Also being compared in this experiment are leys used primarily for

**This is the ninth of a series of articles summarising phases of agricultural research particularly associated with the School of Agriculture since its inception, previous contributions having dealt with:—Physiology of Reproduction, Plant Virus Research, Plant Breeding, Animal Nutrition, Horticulture, Agricultural Economics, Field Drainage and Animal Production. Further contributions on other work will appear in future issues.*

grazing with leys primarily mown, and lucerne-cocksfoot leys compared with rye-grass-clover leys. A somewhat similar rotational experiment, using shorter leys is also in progress on the light soil areas of the farm. Work is also being done on lucerne and lucerne-cocksfoot leys in relation to management problems and the effect of management on productivity and persistency. The lucerne-cocksfoot ley is now one of the most important crops on the farm. The ideal which has been set with all these field experiments has not been simply the measuring of the effects of treatments, but explaining how it is that the effect has been obtained, and what precisely the effect of the treatment had been upon the plant. This involves developmental studies of the plant during the whole season.

The main livestock experiment is concerned with beef production and involves the rearing and feeding of steer calves of the three different types—pure beef, pure dairy and dual purpose—on four different levels of feeding. It will be appreciated that if the results of an experiment of this sort are to be reliable a very large number of animals are necessary (in this particular case about 250) and during the past eight years the number of experimental cattle on the University Farm has rarely been less than 60.

Gravel Hill, when first taken over by the University, was a farm of some 250 acres of which roughly 100 acres were permanent pasture, the remainder being under the plough. The University entered into occupation at Michaelmas 1910 and though in the course of the next 12 years the area had been reduced by the landlords selling off some 50 acres of frontage land etc. for building purposes the remaining 200 acres together with the farm house and buildings still forms the nucleus of the present University Farm. Gault Clay underlies the whole area, but upon the northern side old river gravel varying in depths usually from 4 to 6 feet, but extending in places to a maximum thickness of 20 feet, overlies this clay and in the north-east corner there is a small area of Chalk Marl. Agriculturally therefore the farm consists partly of light land varying from poor sharp gravel, very susceptible to drought, to occasional small areas of better quality mixed soil, and partly of extremely heavy clay. Inherently the soils of which the farm is comprised are of low fertility, there being less than 20 acres which can fairly be described as good land. The light land is too gravelly, and in a dry season burns badly; the average rainfall is low, being only 22 inches, and spring droughts are characteristic of the area. These droughts often bring to light the great variability of the soil; the depth of worked soil above the gravel fluctuating violently from a few inches to a foot or more. Furthermore, the light land is peculiar in that it consists of gravel and coarse sand with a fair proportion of clay but very little silt; thus, though it suffers from all the disadvantages of light land, it is sometimes sticky and difficult to work and shows a tendency to run together on the surface. In some cases a very hard iron pan is encountered at a depth of 7 to 12 inches.

The heavy land is very heavy, a mechanical analysis revealing as much as 50% of clay. It is characteristic of a wide area of similar land in West Cambridgeshire which bears an unenviable local reputation, and which in the twenties and thirties could truly have been described as agriculturally depressed. The one redeeming feature of the gault clay is that it contains a fair proportion of lime.

The sharp contrast between the two main soil types involves widely different treatment as regards cultivations, rotations, mechanisation, crop varieties, the maintenance of fertility and indeed management generally. The farm thus possesses particularly valuable features from a teaching point of view; and its contrasting soils are also a great asset to certain branches of research. On parts of the light land intricate problems of land drainage arise, since the gravel-clay stratification is often highly irregular. Thus tile drainage on the gravel land and mole drainage on the clay both provide valuable teaching material.

When one remembers the way in which Gravel Hill was farmed when it was first occupied by the University it is difficult to realise that it was little more than forty years ago. Conditions were then completely and absolutely different. Labour was the cheapest thing that the farmer could buy and even if machinery had been available it would not have been economic to use it. A man's wages were threepence an hour and the work was much harder than it is today. There was a rigid distinction between grassland and arable land. The grass was all permanent and was situated upon the clay land, only one field of which was ever ploughed. For this there was good reason for not only was the cost of the cultivation of clay land by horses relatively high but little was known about the establishment of grass on poor clay land in a dry climate, and once a clay field was down to reasonably good pasture it was generally thought wisest to let it so remain.

A system of mixed farming was adopted from the very outset and though the system has since been extensively modified yet mixed farming is still the system employed today, and in spite of the advantages of specialisation (and they are real and should not be underrated) it will not lightly be changed, for it is a system that has seen the farm through some very bad and difficult times even if it has not proved as profitable as specialised systems when times were good. Quite apart too from any economic arguments in its favour it is clearly a great advantage from the point of view of teaching to be able to demonstrate the production of a wide range of commodities on a commercial scale.

In 1910 the arable land was farmed on a five course rotation—Roots (sheep keep and mangolds), Barley or Oats, Seeds, Potatoes, Wheat. The stock consisted of five working horses (Shires), a herd of some 20 pedigree Dairy Shorthorn cows—all the calves from which were reared, the heifers as herd replacements and the bull calves (with the exception of one or two each year that were reared and sold for stock purposes) were steered and fed out as baby beef. There was a folding flock of some six score Shropshire ewes—these were lambd in February and the lambs sold off fat. All the straw, hay, roots and oats that were grown were consumed on the farm, and a very limited quantity of cake was purchased each year and fed to the dairy cows, calves, beef cattle and to the lambs. With such a system of farming it was assumed that the land could be kept clean, that fertility could be maintained and that good crops could be grown (good that is for those days) without having recourse to much in the way of artificial fertilisers. The potatoes and mangolds received a liberal dressing of farm yard manure plus a limited quantity of fertiliser while the rest of the root shift received a small quantity of fertiliser only. A top dressing of one cwt. per acre of Sulphate of Ammonia to the wheat and a very occasional application of basic slag to the grassland was the extent of the rest of the manuring. This then was the system of farming which prevailed until 1922, with the exception that during the first world war a 17-acre clay field of

permanent pasture was broken up in order to grow wheat, that a small herd of Large White pigs was introduced and that the Shropshire ewes were replaced by Suffolks.

But 1923 saw the beginning of great changes—the next door farm of Howe Hill, some 200 acres in area, was taken over and the freehold of both it and Gravel Hill was purchased. In 1930 the 300 acre Ladysmith farm, which adjoins Howe Hill was added. Both these clay land farms were in a bad state of cultivation when occupied by the University, being very foul, ill drained, and poverty stricken. The chief reason for taking the Ladysmith farm was to provide an opportunity of giving a large scale trial to that system of farming known as alternate husbandry or ley farming, for it was thought (which has indeed proved to be the fact) that the system held possibilities for the poor clay soils of the eastern counties, soils which can almost be described as ‘marginal’. This, of course, was long before ley farming had received the publicity which it has since enjoyed, and was an effort to work out a system by which such land could be farmed profitably in a time of low corn prices and agricultural depression.

Finally in 1944 a further 60 acres of clay land, the Moor Barns farm, was added. This land was equipped with a set of buildings providing yard accommodation for the wintering of some fifty cattle, accommodation which was badly needed for the large scale beef experiment which was then just being started.

Today the University Farm consists of some 700 acres of which 610 acres are heavy gault clay and 90 gravel. The farm is by no means ideal in shape being long and narrow though it all lies within a ring fence. There are four sets of premises, two being homesteads and in use all the year round, the other two being simply a series of semi-covered yards used for wintering store cattle. The buildings are such as are commonly found in the eastern counties on farms of this character—no better and no worse, a certain number being constructed of brick and slate the balance being wood and tile.

The farming policy pursued to-day is still essentially a system of mixed farming though it should be emphasised that the various departments of the farm are sufficiently large to warrant the full time employment of at least one man. Thus there are enough pigs (20 breeding sows and their progeny fed to bacon weight) to occupy a whole time pigman, enough sheep (14 score of ewes and their lambs) to justify a whole time shepherd, and a dairy herd of 50 cows which with calves to be reared is large enough to require two cowmen.

The total annual sales amount to some £27,000 and are distributed as follows (1953 figures):—

Fat Cattle	...	...	...	...	...	£	4615
Sheep (fat and store lambs)	...	...	...	...	...		2419
Bacon pigs	...	...	...	...	...		7520
Milk	...	...	...	...	...		4815
Eggs and Poultry	...	...	...	...	...		518
Wool	...	...	...	...	...		439
Wheat	...	...	...	...	...		4295
Sugar Beet	...	...	...	...	...		1145
Potatoes	...	...	...	...	...		1073

It will be seen that risks are well distributed; moreover, as the farm is self supporting in livestock, no heavy bills for store cattle, sheep or pigs have to be met.

The main items of expenditure are Labour (£8500), Fertilisers (£1200) and Rent (£1136). Though all the oats, beans and barley grown are consumed on the farm as well as the hay, silage and straw, yet there is a feedingstuffs bill of some £4500. The farm is financially successful.

To-day the work of the farm is done mainly by tractors—two crawlers (invaluable on the heavy land) and four wheeled tractors—though up to 1939 horses were much in evidence and a stud of pedigree Percherons was maintained, four or five foals being bred each year. These strong, hardy, active clean-legged horses suited the conditions admirably and were a profitable side line. But as wages rose and hours of work diminished horses had to give way to tractors and to-day only two or three horses are kept and only an occasional foal is bred.

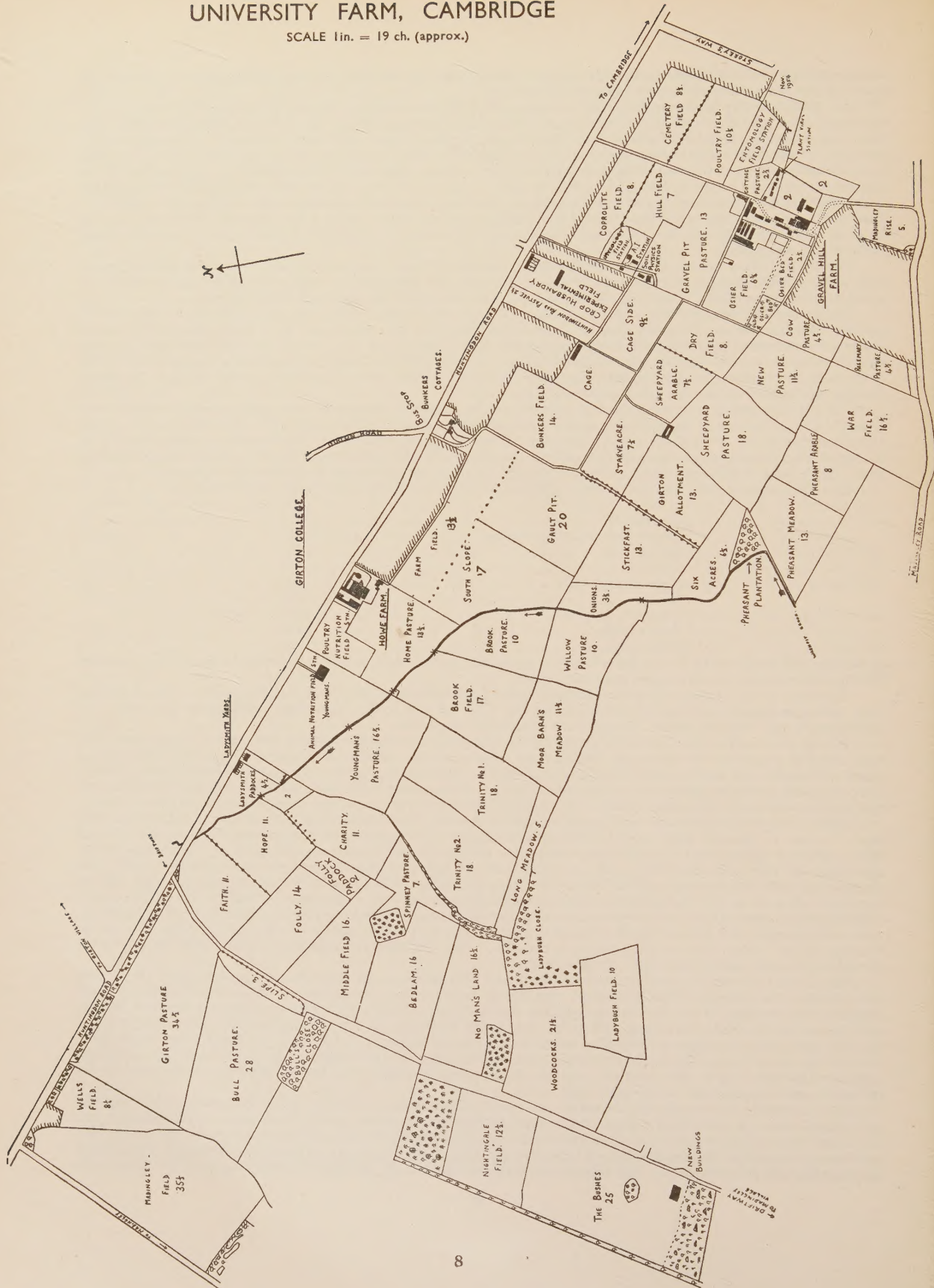
Three different rotations are now practised upon the farm. The first applies to the 90 acres of light gravelly land. As this is the only land on the farm on which roots can be grown with a reasonable prospect of being able to harvest them, what is virtually a two-course rotation is practised, some 45 acres of roots being grown annually. Of this area about 20 acres are sugar beet, 15 potatoes and the rest marrow stemmed kale. The potatoes are followed by oats and the other root crops by barley. The sugar beet and the potatoes each receive farmyard manure as well as artificials and it is found that under such a system of cropping the land is maintained in a high state of fertility and is kept clean with a minimum of effort. In this way root crops may be grown very economically and the farmyard manure is utilised by crops which have a comparatively high cash value. Feeding barley rather than malting barley is the aim, hence stiff strawed high yielding varieties are grown all of which are used on the farm for feeding to pigs.

The second rotation is used on such of the heavy clay fields as are situated close to buildings and which can therefore be dunged at small expense, and which, because they are unfenced and without water, are unsuited to ley farming. It is a five course, seeds in the first year (Red Clover, when the first crop is taken for hay and the second for seed alternating with mixed seeds, the first crop cut for hay and the field then being broken up and bastard fallowed) are followed by wheat in the second and oats or barley in the third. The fourth year is either beans or a crop for summer folding (oats and vetches or trefoil and ryegrass followed by a bastard fallow). The last crop in the rotation is again wheat which is undersown, wheat having proved itself to be the best nurse crop on this heavy clay land.

It would seem as though the ‘bastard’ or ‘pen’ fallow is relied upon as the only means of keeping the land clean. Up to a point this is true, and in the dry Eastern counties, provided no time is lost after the hay has been removed in June (or the crop folded) the land can be kept reasonably clean in this way except for such annual weeds as Slender Foxtail (*Alopecurus agrestis*), Corn Buttercup (*Ranunculus arvensis*), Shepherds’ Needle (*Scandix pecten-veneris*), and Wild Onion (*Allium vineale*). In addition however a good deal of autumn

SCALE 1 in. = 19 ch. (approx.)

SCALE 1 in. = 19 ch. (approx.)



cleaning is practised, the stubble being broken up as soon as the corn has been harvested. The corn harvest is as a rule early in Cambridgeshire and it is unusual not to be able to start breaking up the stubbles by the third week in August and the land continues to be moved at intervals as long as time and weather allow. But neither of these methods deals effectively with the weed association already mentioned, an association which is the result of a long preponderance of autumn sown crops. Unfortunately the obvious remedy of substituting spring for autumn sowing is not really practicable on a large scale for in many years it is not possible to get on to the clay land at all until the date for the successful sowing of spring crops is long past. Fortunately spraying can now deal with some of these weeds very effectively though so far no spray has yet been found which is sufficiently selective to deal with Slender Foxtail in wheat or is effective against Wild Onion. In consequence Slender Foxtail remains the commonest weed on all the clay land fields which are kept permanently under the plough.

The third rotation which is the one used on the greater part of the heavy land represents an endeavour to adapt to the peculiar conditions of the dry eastern counties the long-ley system, or alternate husbandry as it is commonly styled. This system of farming, long familiar in Scotland and in parts of England, has never been generally adopted in East Anglia. It has received a great deal of publicity since the middle thirties but when it was first adopted on the University Farm in 1930 it was a complete innovation in so far as the eastern counties were concerned where the land does not go down to grass so readily and easily as it does in districts of higher rainfall. Moreover there are often special difficulties associated with fencing and water supplies which militate against the system. However it has now been operated successfully on the University farm for some 24 years and much has been learned about its application to the special condition of poor clay land in an area of low rainfall.

The rotation as it is now being practised on the University Farm is as follows—ley occupies the land for from four to six years and is followed by two successive crops of wheat. The second wheat crop is undersown with broad red clover which occupies the third year and finally another crop of wheat is taken which is undersown and then the field put back to ley. It will be noticed that there is a very large proportion of wheat in the rotation. This very heavy land is essentially wheat land and wheat, clover and grass are really the only crops that are naturally suited to it. Of these wheat is the only one that can be cashed directly. The very restricted choice of crop makes this land peculiarly difficult to farm under a system of permanent tillage and also makes it peculiarly vulnerable to times of agricultural depression. Whenever wheat growing has been unprofitable in the past large areas of this type of land in Cambs and the adjoining counties have gone out of cultivation, and have become practically derelict.

The leys are divided between grazing leys and lucerne and cocksfoot. The seeds mixtures used for the former are of the Cackle Park type, and on the whole these general purpose mixtures give a better result than the highly specialised ones. Wild White Clover is of course an important constituent of the mixture and its growth is encouraged by the generous use of phosphatic manure to which the land is very responsive. It was soon found that nothing was more detrimental to the grass and clover leys than taking a hay crop from them. At the same time provision has to be made for the winter and hay must be taken from somewhere. To overcome this difficulty some 50 acres of lucerne and cocksfoot are grown. Lucerne, up to twenty-five years ago, had generally been regarded as a light land crop but it was discovered that it grew exceptionally well on gault clay which is fortunately well supplied with lime, and where it seems very much at home. The first growth of the lucerne/socksfoot in each year is always cut for hay or silage early in June. This means that however dry the weather becomes and however little grass there is as a result, there will still be plenty of green stuff available for grazing in July and August. If the lucerne is not required for grazing it is cut again in July and a third time in September. Thus lucerne and cocksfoot has become the pivotal crop of the whole system for not only does it supply winter keep (approximately 5 tons of hay per acre if cut three times) but acts as an insurance against drought. Indeed without it alternate husbandry would be altogether too hazardous in an area where summer droughts are not unusual and when from mid-June to mid-September in many years the grass just does not grow.

The grazing leys that have been obtained have excited most favourable comment from the many visitors, whom it is very difficult to persuade that the land is inherently poor and of low fertility. These young pastures are remarkably productive in a normal season and the best of them regularly fatten cattle without cake or corn, some 50 of which are sold annually in July or August—all of them home-reared calves and most of them home-bred.

The advantages of farming this type of land under this system have proved to be as follows :—

1. The general level of fertility has been raised. The fields on which it is employed are for the most part remote and difficult of access. To cart farmyard manure to them would be so difficult and expensive as to be uneconomic. They are mostly fields which were taken over in 1930 when they were both starved and foul. It is difficult to see in what other way it would have been possible both to raise the level of fertility and at the same time to have farmed them profitably.
2. A considerable measure of control has been obtained by this means over the particular weed association to which reference has already been made. More particularly is this the case with the lucerne leys. There is no more effective means of eradicating thistles than a thick stand of lucerne left down for five or six years and cut three times each year.
3. In spite of the fact that during the period when the land is under tillage three wheat crops are taken in the four years the crops do not suffer from diseases like Take-All and Eyespot. The long period under ley seems to control these diseases.
4. The physical texture of the clay is improved particularly by lucerne and cocksfoot leys and the land is easier to work.
5. The system is flexible, and emphasis can be placed either on grass or tillage by the length of time the ley is left down. It is often said that a ley deteriorates rapidly after the third year and that it should not be

allowed to remain longer. This is not our experience. Our leys reach their optimum about the third year and if reasonably managed will remain productive for seven or eight years if required. If any change is made it is more likely to be in the direction of lengthening the ley period rather than shortening it.

In addition to land under rotation there are some 100 acres of permanent pasture. A small proportion of this permanent grassland has been improved by ploughing and reseeding, but this method has not been adopted as a general policy for it is only the really old turf which will carry stock when the land becomes at all wet and soft. It is because of this poaching of the land that all the cattle (totalling some 250 head of all ages) have to be wintered in yards. But this is not the only reason why a proportion of old pasture is retained, for it makes a splendid change from the leys, a change which is much appreciated by the cattle which are brought back for a few days to old pasture after they have been grazing leys for a month. It may be no more than the change of flavour which they enjoy but whatever it is they certainly thrive better as a result of the change when they once more return to the leys.

The profitability of any system of ley farming depends more upon the success with which the produce of the ley is turned into money, than upon the excellence and productivity of the ley itself important though this is. At Cambridge leys are used to produce milk, beef and mutton. The farm does not specialise in any one particular branch of livestock, nor does it attempt to produce pedigree stock to sell at high prices, for though much of the stock is pure bred yet the aim is to maintain flocks and herds for the direct production of milk, beef, mutton and bacon. From the point of view of teaching this is considered desirable, for the business of the pedigree breeder is a highly specialised one and pains are taken to impress upon the students that those of them who propose subsequently to farm for themselves (and fortunately there are many) should first satisfy themselves they are able to manage commercial flocks and herds profitably before they embark on the difficult pedigree stock business—if they ever do.

Gravel Hill is the headquarters of the two dairy herds (Dairy Shorthorn and Jersey) and the herd of Essex pigs. Howe Farm is devoted chiefly to calf-rearing and young stock generally while the accommodation at Lady-smith and Moor Barns farms, which consist in both cases simply of a series of semi-covered yards, is used only for housing cattle in the winter. The grassland flock of breeding ewes has of course no particular headquarters.

The present herd of Dairy Shorthorns was founded in 1923 by the purchase of some carefully chosen non-pedigree cows and heifers of good dual purpose type. A policy of grading up was pursued and the descendants of these foundation cows of which the herd is now comprised are all pedigree, the first heifer calves eligible for full registration, i.e. with four top crosses of pedigree bulls, being born in 1935. This herd is composed of some 35 cows in milk. All their calves are retained and are reared by multiple suckling, the best of the heifers for herd replacements and the remainder together with the steers for beef. The calves intended for beef are treated generously for their first 8 months, this is followed with a store period of some 18 months and finishes with 4 months fattening on the leys, the cattle going for slaughter at from 2 to 3 years old. There is nothing unusual in the management of the herd. During the winter the cows spend their time in covered straw yards, a system which has been followed since 1923. The cows are machine milked in three relays in a milking shed which holds 17. Milking is confined to twice a day. Winter feeding consists of lucerne and cocksfoot hay, oat straw and marrow stemmed kale which is replaced by mangolds during February and March. The concentrates are mainly a mixture of home grown oats and beans.

The Jersey herd was only started in 1949 and at present consists of some twenty cows and heifers. They are treated in precisely the same way as the Shorthorns. The whole of the cattle on the farm are attested.

Before the war a flock of some 15 score Border Leicester $\times$ Cheviot ewes was kept, being replenished by the annual purchase of ewe tegs in the spring. Experience has shown that this is roughly the size of flock that can be carried to the greatest advantage; it is small enough to allow plenty of change of common and prevent the land becoming stale; on the other hand, it is large enough together with such lambs as are retained during the winter to provide employment for a shepherd. During the war however, when the area of leys was reduced and much grassland was ploughed up the flock was allowed to dwindle to very small proportions. Unfortunately, when the war was over and an increased area of leys was once more available for grazing the price of Border Leicester $\times$ Cheviot tegs was beyond all reason. It was determined therefore to re-establish the flock by the purchase of regular draft Welsh Mountain ewes, mating them with Border Leicester rams to obtain a flock of Border Leicester $\times$ Welsh ewes. This was done with considerable success, and the ewes of this cross have proved in every way suitable for the conditions, being hardy, prolific and good mothers. They are mated to Suffolk rams and the progeny are mostly sold in the summer and autumn, some fat and some as stores. Some of these Suffolk cross ewes have been retained and the cross taken a stage further. With the exception of some folding of sugar beet tops during the winter the ewes spend their lives on the grass. Lambing takes place in March and April so that the maximum food demands of the flock coincide with the flush of grass in the spring. A couple of acres of mangolds are always grown to provide for the needs of the flock between lambing and the advent of the grass. With a large ewe flock that is maintained on clay land grass little seems to be gained by early lambing.

The present herd of Essex pigs replaced the Large White herd which was unfortunately lost as a result of swine fever in 1940. The herd is composed of some 20 sows the majority of which are crossed with a Large White boar, though a certain number are kept pure. The sows are kept outdoors and farrowed on the tether. This system of tethering was adopted in 1934 and has proved most satisfactory. It is used winter and summer alike. Litter averages are good, anaemia is never seen, and weaning weights average 40 lbs. At weaning the little pigs are brought into grass runs or straw yards for a month where they are fed all the dry meal they will eat. Subsequently they are moved to fattening pens where they are fed slop up to a maximum of 6½ lbs. of meal per head per day.

In this brief description of the Cambridge University farm and its management the writer wishes to make it clear that he makes no claim either to infallibility or originality, nor does he claim that the farming is as good as it might be. He does however claim that the farm fulfils the purpose for which it is designed and fulfils it economically.

* Limited reprints available for free distribution. Please quote marginal number instead of full title. Enquiries for papers not numbered should be sent to the author.

AGRICULTURAL ECONOMICS

The Economics of Crop Spraying.

Fm Econ. Br. Fmr's Bull. No. 16, 1954. Price 2s. Post Free.

The rapid growth in the practice of crop spraying, particularly of weed-killers, is one of the notable changes in farming in recent years. From less than 300 acres in 1931, the area treated had expanded to nearly 2½ million acres by 1952. The purpose of this investigation was to ascertain the cost of this operation, the possible returns and the conditions under which it would pay the farmer to purchase a spraying machine. A survey of 40 low volume and 24 high-low volume machines showed that the average cost (excluding materials) was 6s. 5d. and 9s. 6d. per acre respectively. The cost, however, depends on the area treated. It was shown that for L/V work, 30 acres or more would justify the purchase of a machine and would cost less than the hire of a contractor. In the case of HL/V machines, the capital cost is greater and a 200 gallon machine would require at least 66 acres to justify purchase. Even above the level, the saving in cost is small and may easily be outweighed by other factors, such as the toxicity of the materials used.

It was also shown that the increase in yield necessary to pay for spraying is comparatively small and would amount in the case of cereals to no more than 5 or 10 per cent. Brief consideration was also given to the implications of spraying on grassland management.

Planning a Farm for Higher Productivity. Pp. 36.

Fm Econ. Br. Rep. No. 41, 1954. Price 4s. Post Free.

Since 1939, the volume of machinery on British farms has increased nearly threefold. The output per man has increased by about 30 per cent. Much of this increase, however, is due to the use of better seed varieties, more fertilisers etc. The increase in work accomplished per man has been no more than about 15 per cent. The purpose of this report is to examine the reasons for this slow increase in productivity. In industry, the mechanisation of a process may produce a daily saving in labour which allows of reduction in the permanent staff or an increase in output from the same staff. Owing to the seasonal nature of farm work, the problem is different. Thus the mechanisation of one operation may ease the pressure of work at one season, but may produce no reduction in labour costs unless followed by the mechanisation of labour "peaks" at other seasons.

The problems in the use of mechanisation to increase productivity were illustrated by detailed examination of a typical arable farm. The technique used was that of budgeting and the purpose was to show the extent to which labour saved by mechanisation could be used, either—

- (1) To reduce the permanent labour force without changing the present level of production or
- (2) To use the existing labour force to increase total production.

In the latter case a variety of plans were considered—(a) the introduction of a new crop, (b) the introduction of a dairy herd, (c) the intensification of pig and poultry enterprises, (d) a combination of (a) and (c). It was shown that increases in production per man of up to 35 per cent. should be possible. It was also shown that the use of mechanisation to increase production was likely to produce a greater increase in farm profits than could be realised from merely "saving labour".

It is, of course, impossible to verify experimentally the results of several alternative farm plans. An indirect proof is however obtainable by a comparison with other similar farms. It was shown therefore that the increases in output postulated were in fact being obtained elsewhere and that the increases in profit calculated were in accord with those obtained on other farms with similar resources.

Profitable Milk Production.

Fm Econ. Br. Fmr's Bull. No. 15, 1954. Price 2s. 6d. Post Free.

This bulletin which is based on the results of the milk costing investigation was intended to review some of the economic problems of milk production in an arable area. These included:—

- (a) *Yield per cow.* It can be shown theoretically that the spreading of the "overheads" of milk production (chiefly the maintenance ration) over a greater yield should reduce the cost of production per gallon. This argument is further reinforced by the fact that for any given volume of production, a small herd of high-yielding cows requires fewer acres than a larger herd of low-yielding cows. Hence, a high-yielding herd can release additional land for other uses. This proposition was substantiated from data obtained from the costings investigation.
- (b) *Size of herd.* Increase in the size of herd on an arable farm normally results in a reduction in the output of cash crops. The implications of such a change on the organisation of the farm as a whole were discussed.
- (c) *Winter versus summer production.* Costs per gallon are less in summer than winter. An examination of the data showed, however, that in many cases this was not the determining factor. On average, in 66 herds, grazing supplied from 73 per cent. of starch requirements in May and June down to 43 per cent. in September. In so far as the balance is made up of concentrates, the marginal food cost of milk is virtually the same in summer and winter. If this is so, a transfer of milk production to winter when prices are higher would increase the farmer's income. The problem is however, complicated by the spring "flush" of milk. Thus to obtain more than 50 or more per cent. of production in winter, a large proportion of the calvings must occur in autumn.

A Survey of Producing Wheat in Two Districts in the Eastern Counties, 1952.

Fm Econ. Br. Mimeogr. Rep. No. 49, 1953.

The costs of wheat production on 40 farms in west Cambridgeshire and north Essex.

1218* STURROCK, F. G. & WALLACE, D. B.

Recent Developments in Farm Budgeting.

J. R. Agric. Soc. 1953, **114**, 65-75.

The purpose of this article was to explain the principles underlying the use of budgeting in considering the merits of alternative plans in changing the organisation of a farm. It was illustrated by reference to a farm and the plans discussed included the :—

- (a) raising of yields by use of more fertilisers ;
- (b) intensification of the cropping programme ;
- (c) introduction of a dairy herd ;
- (d) introduction of a pig herd ;
- (e) combination of (c) and (d).

It appears likely that this technique will be of use to the advisory services as a means of showing the farmer that improved practices are not only desirable technically but are likely to improve his income. Emphasis was also laid on the fact that budgeting cannot be regarded as a means of forecasting profits—this is obviously impossible. It can, however, be of use in determining which and under what conditions one course of action is likely to be more successful than another.

OTHER PAPERS

BARNARD, C. S. **Profitable Milk Production.** *Milk Prod.* 1954, **1** (7), 12-13, 15.

CLARKE, G. B. **Know Where You Are Going.** *Fmrs' Wkly. Pig Suppl.* 2 Oct., 1953, pp. 22-4.

1192* CLARKE, G. B. **Muck or Money.** *Pig Fmg.* 1954, **2** (2), 27.

CLARKE, G. B. **Profit in the Balance.** *Fmrs' Wkly. Pig Suppl.* 2 Oct., 1953, pp. 21-2.

CLARKE, G. B. **Profits in Pig Production.** *Pig Fmg.* 1954, **2** (4), 25.

CLARKE, G. B. **Sows for Slaughter.** *Pig Fmg.* 1954, **2** (7), 17.

CLAYTON, E. S. **Home Rearing is Cheapest.** *Fmr & Stk-Breed.* 1953, **67** (3311), 87.

CLAYTON, E. S. **Poultry Costs.** *Fmr & Stk-Breed.* 1953, **67** (3308), 111.

CLAYTON, E. S. **Profitable Poultry.** *Farming Topics No. 7.* Minist. Agric. & Fish. 1954.

CLAYTON, E. S. **Some Financial Aspects of Egg Production.** *Yearb. Poult. Assoc. G.B.* 1954, 49-57.

1184* CLAYTON, E. S. **Winter Egg Production.** *Fmrs' Wkly.* 1953, **39** (16), 69, 71.

MACKNESS, R. A. **An Economist Looks at the Future.** *East Anglian Daily Times.* April, 1954.

NIX, J. S. **Spraying—the Question of Cost.** *Esso Fmr.* 1954, **6** (3), 6-9.

STURROCK, F. G. **Keeping up Farm Income.** *Agriculture: J. Minist. Agric.* 1954, **61**, 138-9.

1224* WALLACE, D. B. **Economy in the Feeding of Concentrates.** *Agriculture: J. Minist. Agric.* 1954, **61**, 226-8.

WALLACE, D. B. **Relationship of Costs to Profits.** *Agric. Rev. Peterborough Ctt. & Advert.* Sept., 1953, p. 9.

AGRICULTURE

BALDWIN, G. G.

Choosing a Disc Harrow.

Fm Mech. 1953, **5** (55), 457-9.

BALDWIN, G. G.

Why the Separate Engine ?

Fmrs' Wkly. 1954, **40** (19), 79-81.

BROOKES, A. J.

Rearing Young Stock.

Worcs Agric. Chron. 1954, **22**, 13-19.

1194* ENGLEDDOW, F. L.

Agricultural Policy in Colonial Territories.

Rep. Conf. Dir. Col. Dep. Agric., Wye, Kent, 1953.

Col. Off. Misc. No. 519, 115-22.

Trop. Agric. 1954, **31**, 3-10.

HANLEY, F.

Recruitment and Training of Agricultural Probationers.

Rep. Conf. Dir. Col. Dep. Agric., Wye, Kent, 1953.

Col. Off. Misc. No. 519, 107-12.

MANSFIELD, W. S.

The University Farm.

Golden Sheaf. 1954, **8** (4), 8-11.

ANIMAL BREEDING AND GENETICS

1208* JOUBERT, D. M.

Breeding for Beef in Tropical and Sub-Tropical Climates with Special Reference to the Continent of Africa.

Colon. Pl. Anim. Prod. 1954, 4, 1-13.

Africa, taken as a whole, is the most tropical of the continents, its greatest mass lying within the tropical zones. Though vast areas are suited to cattle ranching for beef production, climate and nutrition frequently limit utilisation of the available resources. In the discussion the extent of these limitations in Africa is surveyed and experimental data are quoted to indicate the reaction of different types of cattle to such environments. In the light of evidence gained by research on these problems, possible solutions for increased beef production in tropical and sub-tropical regions are put forward.

PEASE, M. S. & DUDLEY, F.

Hybrid Vigour in Poultry.

Proc. 10th World's Poult. Congr. 1954, 45-9.

Five lines of White Leghorns have been bred at Reaseheath, Cheshire, England, by continued brother : sister mating, starting at various dates between 1933 and 1940. An experiment was begun in 1944 to find out the effect of heterosis on six measurable characters in each of the 20 possible incrosses from these five lines. The six characters measured were (1) age at sexual maturity, (2) weight at sexual maturity, (3) number of eggs laid in 44 weeks from date of first egg, (4) body weight at the end of the test period, (5) average egg weight, and (6) mortality.

The comparisons were not with the inbred parent lines, but with pullets from a stock of White Leghorns bred at Reaseheath so as to be as heterozygous as possible; in each case comparison was between incross pullets and outcrossed pullets hatched at the same time. The object of the experiment was to test whether there is any substance in the claim that preliminary inbreeding increases the heterosis effect, either generally or specifically in certain incrosses.

In sexual maturity, body weight, and egg weight the incrosses almost all fell behind the corresponding control stock. But in viability and egg production many of the incrosses proved superior to the controls. Six incrosses had significantly lower mortality than the controls, none had significantly higher mortality and in 14 incrosses the differences were insignificant. In the case of egg production, 12 incrosses laid better (5 substantially) than the controls and 7 showed no significant differences, and one laid significantly worse than the control. The experiment did not reveal any clue by which the performance of an incross could be predicted.

PEASE, M. S.

Sex-Linkage in Poultry Breeding, 5th ed.

Bull. Minist. Agric. No. 38, 1954. (H.M. Stat. Office, London, 3s.).

An account of sex-linkage and of the new Cambridge autosexing breeds of poultry.

OTHER PAPERS

HAMMOND, J. **Selection for Wool Quality.** *Esso Fmr.* 1954, 6 (2), 10.

ANIMAL NUTRITION

1196* EVANS, R. E.

Nutrition of the Bacon Pig. XVII. Nutritive Value of Condensed Fish Solubles.

J. Agric. Sci. 1954, 44, 100-20.

The investigations described in this paper are concerned with the nutritive value of condensed whale and fish solubles, both from the point of view of A.P.F. supplementation of the diet and also from the standpoint of the biological value of the crude protein. Fish solubles contain 5.3% of nitrogen on the moist (50% dry matter) basis, or 33% of crude protein. Of the crude protein about one-third or less is present in the form of 'true protein'. The possible use of condensed fish solubles as a protein concentrate for supplementing the proteins in cereal grains has therefore been investigated.

The work has been carried out by statistically-designed growth trials as well as group-feeding trials, and the results have been tested further by carrying out nitrogen-balance determinations in the metabolism crates.

The same basal diet was employed throughout and was composed roughly of 2 parts of barley meal and 1 part of fine bran, together with a little artificially dried lucerne meal and minerals. To test whether fish solubles supplied A.P.F. or not, 3% and in some cases 4% by weight was added to the basal foods. Thus fish solubles were added to all-vegetable diets supplemented with either extracted soya-bean meal, extracted decorticated ground-nut meal or dried brewer's yeast, so that the digestible crude protein was equal to, or in excess of, a similar diet supplemented with 7% of white-fish meal. Negative results from the standpoints of increased rate of live-weight gain and economy of food conversion were obtained in all cases. This might be interpreted as indicating that the solubles were either lacking in A.P.F. or that the pigs had body reserves of A.P.F., carried over from the suckling period, or produced by bacterial synthesis in the large intestine. They were thus able to grow at a normal rate independent of any dietary source of the factors. There was no evidence either from the growth trials or from the nitrogen-balance determinations that would warrant the conclusion that the fish solubles contributed anything more to the diet than would be accounted for by the supplemental effect of its protein content. The addition of 3 or 4% of fish solubles to supply A.P.F. did not improve the efficiency of the vegetable proteins so as to make them lb. for lb. equal to the animal proteins in white-fish meal.

To test the supplemental value of the so-called crude protein in the fish solubles, enough of the solubles was added to the barley meal-fine bran diet in the first trials to bring the crude protein content to the same level as a similar diet supplemented with 7% of white-fish meal. Allowance was made for the high moisture content of the fish solubles, and care was taken to ensure that the total digestible nutrients were approximately the same on all treatments. In order to check the equality of the diets in respect of their content of digestible nutrients, the feeding of the solubles was continued in the period from 90 to 150 lb. live weight, when the supplemental effect of the crude protein should not affect the rate of live-weight gain. When the contribution to the digestible crude protein supply by the fish solubles and white-fish meal, respectively, was almost equal, the nutritive value of the crude protein in the fish solubles was found to be distinctly inferior to that of the fish-meal proteins. This was confirmed by nitrogen-balance determinations. Nevertheless, the results showed that the crude protein in the fish solubles had a very real supplemental value for the proteins in cereal grains.

One disadvantage found throughout in using fish solubles as the sole protein concentrate was the fact that the diet became rather unpalatable. Even in small amounts the fish solubles have an adverse effect on the palatability of the ration.

When 18 parts of fish solubles were added to 91 parts of the basal cereal meals, almost as good a retention of nitrogen was observed as with the standard-protein diet supplemented with 7% of white-fish meal. The fish solubles supplied 5.69 lb. of digestible crude protein per 100 lb. air-dry food as compared with 4.08 lb. by the white-fish meal. When the same treatments were compared in the growth trial, however, the pigs receiving 18 parts of fish solubles increased in live weight, between 40 and 90 lb. live weight, at the rate of 0.91 lb. per day, whereas the pigs receiving the diet supplemented with 7% of white-fish meal made a daily gain of 1 lb. per day. The contribution made to the crude protein supply of the diet by the fish solubles was 36% and by the white-fish meal 27%. Since equi-caloric diets were fed, we may conclude, therefore, that although the nutritive value of the crude protein in fish solubles is considerable, its supplemental value is distinctly lower than the crude protein in white-fish meal. The unpalatability of the diet containing 18 parts of fish solubles must, however, have been a contributory factor and would tend to give too low an estimate of the distribution of the essential amino-acids in the fish solubles due to the longer time taken in feeding and to a greater wastage of food on the standing platforms.

1197* JOUBERT, D. M.

Influence of Winter Nutritional Depressions on the Growth, Reproduction and Production of Cattle.

J. Agric. Sci. 1954, **44**, 5-66.

During the period May 1948 to May 1952, a study was made of the influence of seasonal fluctuations in the nutritive value of the natural pastures in the Bankenveld region of the Transvaal, on the growth, reproduction and production of cattle. The paired method of investigation was adopted, each heifer maintained on grazing alone having a related counterpart of the same age which received supplementary feeding during the winter months. The former treatment was termed 'low plane', and the latter referred to as the 'high plane'. Four breeds were included in the investigation, viz. Friesians and Jerseys, and Shorthorns and Afrikaners, thus being representative of both dairy and beef types. The latter breed also represented the stock indigenous to South Africa. Initially five pairs per breed were studied, but deaths and other causes depleted the numbers to twenty-eight head after 4 years of investigation.

Since the investigation formed part of a series of studies which have been in progress at the University of Pretoria and Agricultural Research Institute during the past two decades, the results of which hitherto remained unpublished, a review is provided in the early chapters. To furnish some indication of the natural conditions ruling in the Bankenveld region, the agro-ecological background is discussed, particular attention being paid to physical and nutritional factors. It is shown that for at least 6 months of the year the climate tends to be subtropical, whilst the results of digestion trials on pasture samples, indicated serious nutritional depressions in the natural grazing during winter.

Growth was recorded by weekly weighing of all animals, and developmental changes by linear body measurements taken at 3-monthly intervals. A photographic record of the experimental animals was also kept to illustrate the conformational changes resulting from different treatments.

The results indicated that growth in body weight of the low-plane groups showed marked seasonal fluctuations. These usually reached a peak at the end of summer, and then dropped fairly rapidly to the lowest level which was reached just prior to the first spring rains. Significant correlations between T.D.N. (Total Digestible Nutrients), percentages of pasture samples collected at the time, and mean daily rates of gain, showed that seasonal fluctuation in live weight is closely allied to corresponding variations in the nutritive value of the natural grazing. Distinct breed differences were also recorded. Under optimum conditions (High plane), the indigenous breed made the fastest relative gains, but on the low plane the Jerseys were distinctly superior.

It was shown that the poor nutritional conditions prevailing during winter significantly retards developmental growth. The differences between high and low-plane animals continued to be noticeable even after 4 years of investigation, breed variations being evident. The Shorthorns were obviously more severely stunted than any other breed and the Jerseys least of all. Furthermore, all anatomical dimensions were not affected to the same degree by adverse nutritional conditions. Whereas skeletal development was merely slowed down or stopped during winter, measurements indicative of muscular development actually showed significant decreases. A tendency for the low-plane individuals to make higher relative increases in summer than the High-plane groups was, however, revealed.

The reproductive aspects investigated included the first exhibition of oestrus, i.e. puberty, the stage at which a desirable weight for mating was reached, and the age of first and subsequent calvings. Growth during pregnancy and maternal influences on the size of offspring at birth also received particular attention.

In comparing the influence of early and late breeding on growth, it was found that the age of first calving has no permanent influence on the ultimate size of the animal. The growth made during pregnancy, however, differed appreciably between high- and low-plane heifers, the latter having increased much less in weight. The loss in weight resulting from parturition was also appreciably less for the low-plane group and, on an average their calves weighed 7.5 lb. less at birth.

The low nutritional plane delayed puberty on an average by 221 days, and it was actually possible to have the supplemented individuals served 9.6 months earlier than their low-plane counterparts under normal conditions of experimentation. A tendency was also revealed for the whole subsequent reproductive cycle to be retarded by adverse nutrition.

Production was measured by the actual milk yields, and butterfat yields and percentages in the case of the dairy breeds, while the growth of the calf served as a criterion of milking capacity for the beef bred animals.

The results demonstrated a distinct difference between beef and dairy heifers in their growth rates during lactation. Whereas the heifers from the dairy breeds continued to grow steadily throughout lactation, the tax on the cow suckling a calf was evident from the fact that weight was lost until the tenth month after calving. The high-plane beef breed heifers showed relatively greater losses during lactation due, probably, to higher milk yields. On the other hand, among the dairy heifers, all of which received identical treatment after calving, the low-plane individuals grew at a rate nearly twice that of the high-plane group.

The growth rate of calves suckling their dams were greatly influenced by the milking capacity of the cows. The low nutritional plane obviously resulted in a decreased milk flow which, in turn, caused lower weaning weights of the calves concerned. All the dairy breed calves were separated from their dams shortly after birth and were raised strictly in relation to weight. Even though the low-plane calves weighed less at birth, there was no sign of pre-natal influences left at an age of 12 months.

It was statistically shown that none of the differences in milk yields and butterfat percentages of high- and low-plane heifers were of significance. The monthly production values indicated, however, that although the low-plane heifers started off at a lower level of production, they maintained much greater persistency.

An estimate was made of the feed requirements of growing heifers during periods of nutritional depression in the natural grazing within the Bankenveld region.

ANIMAL PATHOLOGY

1212* LAWSON, M. R. & ROWSON, L. E. A.

The Use of Cortisone in the Treatment of Arthritis in a Bull.

Vet. Rec. 1953, **65**, 506.

The authors report on the clinical improvement obtained, when repeated injections of cortisone were given, to a bull showing extremely severe arthritis of the hind legs.

Withholding treatment very soon caused the return of symptoms which were again removed following a further course of treatment with cortisone and aspirin.

When treatment was finally stopped the animal very soon became a complete cripple, unable to rise, and had to be slaughtered. The improvement obtained during the actual treatment was, however, so great that the bull was at this time able to serve normally.

1198* MILLEN, J. W., WOOLLAM, D. H. M. & LAMMING, G. E.

Hydrocephalus Associated with Deficiency of Vitamin A.

Lancet. 1953, 1234.

Hydrocephalus occurring in young rabbits as a direct consequence of vitamin-A deficiency in the mothers has been investigated.

The underlying cause of this hydrocephalus is stenosis of the cerebral aqueduct.

The hydrocephalus has been held to be responsible for the constriction of the optic nerves and for the paralyses found in these animals.

These findings are discussed in relation to genetic hydrocephalus and to reports on the effects of vitamin-A deficiency on laboratory and farm animals.

The discovery of maternal vitamin-A deficiency as a cause of hydrocephalus in the progeny throws open an entirely new field for clinical investigation into the pathology of hydrocephalus, and for experimental observation on the physiology of the cerebrospinal fluid.

ANIMAL PHYSIOLOGY

1204* BISHOP, M. W. H., CAMPBELL, R. C., HANCOCK, J. L. & WALTON, A.

Semen Characteristics and Fertility in the Bull.

J. Agric. Sci. 1954, **44**, 227-48.

Certain characteristics of bull semen have been examined at four artificial insemination centres in England. One hundred and twenty-one samples of semen, comprising 168 ejaculates from seventy-six bulls of seven breeds, were examined. The semen from 119 tested samples was subsequently used to inseminate 4604 cows.

The following semen characteristics were studied: volume of ejaculate; concentration of spermatozoa; incidence of dead spermatozoa; incidence of morphologically abnormal spermatozoa; initial fructose concentration; resistance of spermatozoa to temperature shock; methylene-blue reduction; O_2 uptake; fructose

utilisation ; visual evaluation of motility ; impedance change frequency ; and fertilising capacity (conception rate).

A clinical examination was made of the reproductive organs of each bull.

Variations in the concentration of living spermatozoa and in the incidence of dead spermatozoa were found to account for most of the variations in the metabolic activity of semen : they also largely explained differences in physical activity as assessed by visual estimation of motility or by impedance change frequency.

Although the rates of methylene-blue reduction, O_2 uptake and fructolysis showed a close correlation with the numbers of living spermatozoa present, O_2 uptake and fructolysis per living cell decreased with increasing cell concentration.

Variations in metabolic activity showed no correlation with variations in the morphological characteristics of the spermatozoa, except in the case of spermatozoa with bent tails. These forms occurred in some samples as a result of staining treatment, but their incidence was positively correlated with the O_2 uptake and fructolysis per living cell.

There was evidence that highly active spermatozoa are more resistant to temperature shock than less active spermatozoa.

The relationships between fertility and the other semen characteristics differed between centres, but analysis of the total data established a highly significant inverse relationship between fertility and the incidence of dead spermatozoa, and a highly significant direct relationship between fertility and impedance change frequency. There was also evidence of relationships between fertility and resistance to temperature shock, age of bull, volume of ejaculate, fructolysis and methylene-blue reduction. There were significant differences in fertility between breeds ; there were no obvious relationships between the palpable characteristics of the genital organs or the libido of the bulls and their fertilising capacity.

These results provide evidence of a relationship between the physical activity of bull semen and its fertilising capacity. This activity is determined by the number of living spermatozoa in the semen and their degree of activity, and can be measured by the following tests : determination of concentration of spermatozoa ; determination of the incidence of dead spermatozoa ; and measurement of impedance change frequency.

The results show that the metabolic tests (methylene-blue reduction, fructolysis and O_2 uptake) add little to the information gained by the three tests mentioned above.

The results were obtained on a selected sample of bulls and the conclusions which have been drawn may not apply to bulls generally.

1188* COMLINE, R. S., POMEROY, R. W. & TITCHEN, D. A.

Histological Changes in the Intestine during Colostrum Absorption.

J. Physiol. 1935, **122**, 6P.

Changes, associated with the absorption of colostrum globulins, have been detected in the intestinal epithelial cells of piglets and kittens after they had suckled colostrum.

In paraffin sections of the small intestine taken from new-born kittens and pigs within 6–18 hr. of the ingestion of colostrum, globules of material from 0.5 up to 10 μ in diameter, which stained black with iron haematoxylin and red with azocarmine, were detected in the intestinal epithelial cells. Their position in the cell varied ; in sections from animals killed about 6–8 hr. after suckling they lay mainly in the upper half of the cell, the nucleus occupying a basal position. In two piglets, killed 15 and 18 hr. after suckling, the globules were in the basilar half, and the nuclei lay in the upper half of the intestinal epithelial cells. Material staining in a similar manner to the globules was also detected within the lacteals, especially those taken from animals 15–18 hr. after they had suckled.

The intestinal cells of animals up to 48 hr. old, which had not suckled, did not show any globules within the intestinal epithelial cells (or material within the lacteals) which stained with iron haematoxylin or azocarmine. There were, however, large vesicles or vacuoles within the epithelial cells of the small intestine. These vacuoles were also present in suckled animals up to 48 hr. old, and in the intestine of the foetus within the last 2–3 weeks of intra-uterine life. They have not been stained with certainty in paraffin or frozen sections of Suza or formol-saline fixed tissue.

1183* DOTT, H. M.

Dark-Ground Illumination of Ram Spermatozoa.

Nature, Lond. 1953, **172**, 626–7.

By this method twisted mid-pieces can be demonstrated in live sperm treated with nigrosin and eosin. It is suggested that this provides a mechanism for the rotary movement of sperm.

1190* EDGAR, D. G.

Progesterone Content of Body Fluids and Tissues.

J. Endocrin. 1953, **10**, 54–64.

By means of a chemical assay method (Edgar), progesterone was found in blood from the vein draining an active ovary in the pregnant and non-pregnant ewe and in the non-pregnant sow. It was not found in blood from the ovarian vein of a ewe with inactive ovaries, nor in peripheral blood of the pregnant and non-pregnant ewe, mare, cow, sow, and female rabbit, nor of the castrated ram.

The hormone was present in fluid from the mature Graafian follicle of the cow and sow, and in fluid from pathological ovarian cysts in the sow.

The progesterone content of corpora lutea from the sheep, calf and elephant was also determined.

1214* GLOVER, T. & MANN, T.

On the Composition of Boar Semen.

J. Agric. Sci. 1954, **44**, 355-60.

Twenty ejaculates were collected from the same boar at weekly intervals; the composition of semen was studied by microscopic and chemical methods. The total volume of ejaculates varied from 240 to 500 ml., and sperm concentration from 50,000 to 177,000 cells/ μ l. Chemical analysis revealed 2.4-12.6 mg./100 ml. fructose, 5.9-23.1 mg./100 ml. ergothioneine, and 32-156 mg./100 ml. citric acid.

The sequence with which the different parts of boar semen follow one another at ejaculation was studied by the method of fractionate collection. The earliest to be emitted was the 'pre-sperm fraction' from which sperm and seminal vesicle secretion were absent. The next was the 'sperm-rich fraction' which showed not only a high sperm content but contained also substantial quantities of substances derived from the seminal vesicles, i.e. fructose, ergothioneine and citric acid. The 'post-sperm fraction' consisted mainly of accessory gland secretions.

The analysis of semen fractions collected at very brief intervals has shown that whereas the secretion of the seminal vesicles accompanies the spermatozoa at ejaculation, it attains its maximum immediately after the bulk of the sperm has been ejaculated.

1201* HAMMOND, J.

Problems of Reproductive Hormone Action.

Acta Physiol. Latinoamer. 1953, **3**, 114-7.

A survey of recent work indicates that the sex hormone balance in cattle affects the susceptibility of the uterine mucosa to infection. While oestrogens enable the mucosa to throw off infections, progesterone causes it to become extremely susceptible. A considerable amount of evidence is also available to show that the quantitative effect of a given dose of hormone is dependent on the plane of nutrition of the animal into which it is inserted. This applies to the effect of oestrogens on the mammary glands of cattle, and to F.S.H. on the ovaries of rabbits, calves and sheep.

HAMMOND, J. (*Editor*).

Progress in the Physiology of Farm Animals.

Vol. 1. Pp. viii+392. (Butterworths Sci. Publ., London, 1954. 45s.)

An account of the newer knowledge on the subject brought together so as to make it easily available to advanced students and those who are engaged in teaching animal production. Each chapter is written by an author who has taken an active part in this progress. Volume 1 consists of chapters on Nutrition and Metabolism (Ruminant Nutrition; Pig Nutrition; Poultry, and Trace Elements) and on Environment (Ecology of Domestic Animals; Environmental Physiology of Farm Mammals; Heat Regulation in Birds, and Day-light Changes).

1202* HAMMOND, J.

Some Possible Causes of Sterility.

Ann. Ostet. Gynec. 1953, (6), Fasc. Spec. No. 3, 17-23.

Several possible causes of sterility are suggested by experiments which have been made on multiple ovulation and egg transplantation. They are as follows:

The egg may be dead before it leaves the follicle when ovulation is too long delayed.

The egg may, under the influence of progesterone, pass too quickly down the tubes and so either not become fertilised or perish in a uterus which is not yet ready to receive it.

Penetration of air into the uterus during the luteal phase of the cycle may not only cause death of the developing egg but also infection of the uterine mucosa.

Much early foetal atrophy occurs about the time of implantation and suggestions are made as to possible causes.

1180* HAMMOND, J.

Sterility and Habitat.

Zoot. Vet. 1953, Spec. No. pp. 41-46.

The two main anterior pituitary hormones which control the functioning of the ovaries are F.S.H.* which causes the follicles to ripen and L.H.* which causes ovulation and the formation of the corpora lutea. These two hormones by their action on the ovaries cause the formation of oestrogen and progesterone respectively. The relative proportions of these two gonadotrophic substances, as well as their actual amount, is important for, as shown by comparison between species, these proportions determine the nature of the oestrous cycle and time of ovulation. The relative proportions of the two ovarian hormones are also important for the attachment of the fertilised egg and the proper development of the embryo.

In some species such as the horse and sheep the output of hormones by the anterior pituitary gland is determined by the relative length of daylight-darkness hours. These species can be made to breed or not to breed at will by changing the ratio of light to dark, long light-short dark causing increased anterior pituitary output in the horse and the reverse causing it in the sheep.

*F.S.H. (Follicle Stimulating Hormone); L.H. (Luteal Hormone).

The time of ovulation in relation to the end of heat varies in different species according to the balance of F.S.H. and L.H. secretion from the anterior pituitary gland. Since the life of the sperm and the unfertilised ovum is very short in the female tract, the time of mating or insemination in relation to the end of heat is important. This is particularly important in the mare where the time of ovulation can be controlled by injection of L.H.

The ascent of the sperm to the tubes is controlled like the "letting down" of milk, by the release of oxytocin from the posterior pituitary, and consideration should be given to the implications resulting from this.

Some 25-30% of sterility in cattle is due to the early death of the fertilised egg and a fairly high proportion of foetal atrophy also occurs in other species. The cause of this is not yet definitely established but there is a presumption that hormone balances unfavourable to the development of the fertilised egg are concerned, for foetal atrophy can be caused experimentally by increasing by hormone injections the numbers of eggs normally shed by the species.

1220* HUNTER, G. L.

Attempts to Synchronize the Occurrence of Oestrus in Sheep as a Preliminary to Ovum Transplantation.

J. Endocrin. 1954, **10**, xiii.

Synchronisation was effected by injecting 10 mg. crystalline progesterone in 2 ml. arachis oil. 47% of the ewes came on heat less than 3 days after the treatment ended. Oestrus occurred again in 30% of the ewes on the 18th day, 47% on the 19th day and 17.5% on the 20th or 21st day after the treatment ended.

1216* LEWIS, P. R. & LUTWAK-MANN, C.

The Content of Sodium, Potassium and Chloride in Rabbit Blastocysts.

Biochim. Biophys. Acta. 1954, **14**, 589-90.

Determinations were made from 6 to 10 days. By comparing the sum of sodium and potassium with that of chloride and bicarbonate, it was found that up to 7½ days they are balanced but afterwards diverge by a decrease in bicarbonate content. As implantation of the blastocysts nears completion anions other than chloride and bicarbonate appear in the blastocyst fluid.

1215* LUTWAK-MANN, C.

Note on the Chemical Composition of Bovine Follicular Fluid.

J. Agric. Sci. 1954, **44**, 477-80.

Follicular fluid was collected by aspiration from the ovaries of cows which had been treated with pregnant mare serum, and were killed 3-4 days after heat.

Various chemical determinations have been carried out with samples of follicular fluid which, amongst others, was found to contain 39-43 mg./100 ml. of glucose, between 13 and 95 mg./100 ml. of lactic acid, and 0.8-3.0 mg./100 ml. of ascorbic acid.

The effect of follicular fluid upon sperm fructolysis was examined; however, no effect other than that due to the glucose content of the follicular fluid, could be observed.

LUTWAK-MANN, C.

Some Properties of the Rabbit Blastocyst.

J. Embryol. Exp. Morph. 1954, **2**, 1-13.

A study of certain chemical components of the rabbit blastocyst was carried out using material available at 6, 7, 8, and up to 12 days after copulation. For chemical determinations unimplanted blastocysts were used whole; from the implanted blastocysts, the fluid filling the interior was withdrawn by aspiration. The content of nitrogen, chlorides, Na, K, Mg, and Ca was determined. Glucose was identified in yolk-sac fluid and its concentration before and after implantation was determined.

The passage from maternal blood into the blastocyst fluid was investigated during a 30-60 minute interval following parenteral administration of glucose, fructose, sucrose, sulphapyridine and thiocyanate. Under the experimental conditions of this study all these substances, except thiocyanate, passed freely into the fluid of the fully implanted blastocyst 8 days after mating. None, however, was able to penetrate into the unimplanted blastocysts. During the initial phase of implantation glucose entered the fluid more readily than either fructose or sucrose.

In hyperglycaemic alloxan-diabetic rabbits the glucose concentration in the blastocyst fluid represented only a fraction of that found in the maternal blood.

Data are presented for the distribution of glycogen and phosphorus in the rabbit uterus, 7½-8 days after copulation, at the level of implantation, and in the inter-implantation areas.

1219* MAQSOOD, M.

Effects of the Thyroid State, Season and Castration on the Adrenal Glands in Male Rabbits.

J. Endocrin. 1954, **11**, 103-9.

The influence of the thyroid state, season and castration on the weight of the adrenals of the young male rabbit at different ages has been studied. Administration of thyroxine in doses about 30-50% above the estimated rate of secretion of thyroxine for a period of 4 weeks resulted in a significant increase in the weight

of the adrenals, while treatment with thiouracil caused a significant decrease in adrenal weight. Thyroxine, when injected in doses below or about equal to the estimated rate of thyroxine secretion, did not affect the weight of the adrenals. On the other hand, prolonged mild hyperthyroidism resulted in an insignificant decrease in the weight of the adrenals.

The weights of the adrenals in experimental and control animals during the summer months were significantly lower than those obtained in the winter. This was probably due to a decrease in the rate of secretion of thyroxine which occurred presumably as a result of high environmental temperature during the summer. Castration did not affect the weight of the adrenals of 8-week-old male rabbits after a period of 4 weeks, but resulted in a significant increase in the weight of the adrenals after a period of 24 weeks.

The possible existence of an interrelationship between the thyroid, adrenals and gonads is discussed.

1185* MARDEN, W. G. R.

Hormone Control of Ovulation in the Calf.

J. Agric. Sci. 1953, **43**, 381-406.

Unlike many other mammals, the calf is capable of responding to pituitary injections almost from birth. Age has little effect on the ability of the follicles to develop during a series of A.P.H.* injections, the follicular response generally being as good 3 weeks after birth as in calves 6-8 months old.

Ovulation can occur spontaneously in the A.P.H. treated calf before the end of the first month of post-natal life.

Ova obtained from such ovulations are capable of fertilisation, although the percentage becoming fertilised is very low. This is thought to be due to the infantile state of the Fallopian tube and the difficulty in inseminating into the uterus, rather than faulty maturation of ova.

Although many follicles (10-60) can develop during a series of A.P.H. injections, superovulation was not consistently obtained either by intravenous injections of A.P.H., L.H.* or P.U.,* or combinations of any of these three.

Superovulation can generally be obtained, with the formation of many corpora lutea, if the A.P.H. treatment is repeated a second time after a period of luteal activity.

The inhibitory effect of a corpus luteum on ovulation in cattle can be overridden in the A.P.H. treated animal if suitable quantities of A.P.H., L.H. or P.U. are intravenously injected when the newly formed follicles are approaching maturity.

Ovulation in the calf at all ages up to 8 or 9 months of age, either in the presence or absence of luteal tissue, is unaccompanied by oestrus. Oestrus, when occurring during a series of A.P.H. injections, commenced after 90-100 hrs. of treatment. In such cases slaughter has always revealed the presence of luteal tissue, indicating that ovulation during a 'silent heat' had occurred before the commencement of pituitary treatment.

Great individual variation exists in the ability of the ovary to respond to pituitary injections. This insensitivity to gonadotropins is not confined to young calves and has been observed in calves 4-6 months of age.

OTHER PAPERS

ADAMS, C. E. **Some Aspects of Ovulation, Recovery and Transplantation of Ova in the Immature Rabbit.** *Contr. to Ciba Foundation Symposium on Mammalian Germ Cells*, pp. 198-212. Churchill, London, 1953. 30s.

BISHOP, M. W. H., CAMPBELL, R. C. & HANCOCK, J. L. **Semen Characteristics and Fertility in the Bull (Summary).** *Contr. to Ciba Foundation Symposium on Mammalian Germ Cells*, pp. 103-7. Churchill, London, 1953. 30s.

1186* DOTT, H. M. & WALTON, A. **Apparatus for Studying Semen Metabolism and Sperm Motility under Constant Fluid Perfusion and Known Gaseous Partial Pressure.** *J. Physiol.* 1953, **122**, 1 P.

HAMMOND, J. **Fertility in Sheep.** *Esso Fmr.* 1954, **6** (1), 4.

ANIMAL PRODUCTION

1195* BROCHART, M.

Attempted Experimental Production of Identical Twins in Rabbits.

Nature, Lond. 1954, **173**, 160-3.

Three main methods have been tested, (1) mechanical separation of the blastomeres, (2) chemical separation of the blastomeres, and (3) chemical dissolution of the zona pellucida. Of these (1) seems the most promising; in culture a few treated eggs divided to the 4-cell stage. The time the division of the eggs occurs in normal twinning is unknown.

1200* CAMPBELL, R. C. & EDWARDS, J.

Semen Diluents in the Artificial Insemination of Cattle.

Nature, Lond. 1954, **173**, 637.

The effects on conception rate of citrate and phosphate buffer solutions in the semen diluents and of sulphanilamide, streptomycin and penicillin supplements were studied in an experiment involving 68,713 inseminations. Treating unsupplemented citrate buffer solution (with egg yolk) as the control diluent, egg-yolk phosphate buffer+penicillin improved conception rate by 9.3%, egg-yolk citrate buffer+sulphanilamide, streptomycin and penicillin improved conception rate by 6.8%, and unsupplemented egg-yolk phosphate buffer improved conception rate by 5.5%.

*A.P.H. (Anterior Pituitary Hormone) : L.H. (Luteal Hormone) : P.U. (Pregnancy Urine).

1222* HAMMOND, J.

L'Amélioration du Bétail en Grande-Bretagne.

Ann. Med. Vet., Bruxelles. 1953, **7**, 374-83.

Chronicle (Stud Book Suppl.), Adelaide. 26 Aug., 1954, p. 53.

An outline is given of the scientific basis on which the methods of improvement for milk and meat production are being effected.

1211* ROWSON, L. E. A. & MURDOCH, M. I.

Electrical Ejaculation in the Bull.

Vet. Rec. 1954, **66**, 326.

The paper describes a simple apparatus for the electrical collection of semen from bulls using direct stimulation of the ampullae by means of ring electrodes worn on the fingers of a rubber gloved hand. The value of the instrument for lame and aged bulls which cannot serve normally is stressed. Fertility resulting from the use of semen obtained in this way was found to be very high.

ROWSON, L. E. A. & POLGE, C.

Storage of Bull Semen at -70°C. and Fertility Results for up to Twelve Months.

Vet. Rec. 1953, **65**, 677-9.

Bull semen diluted 1 : 4 in the presence of 10 per cent. glycerol has maintained normal fertilising capacity during one year's storage at -79°C.

Seven out of 12 cows became pregnant following insemination with semen diluted 1 : 100 and kept frozen at -79°C. for 2 to 24 days.

Bull semen frozen at -192°C. in liquid air showed similar motility on thawing as semen frozen at -79°C. in solid CO₂.

A number of "deep-freeze" storage units are described.

1213* VAN RENSBURG, S. W. J. & ROWSON, L. E. A.

The Fertilising Capacity of Frozen Bull Semen after Long Distance Aerial Transport.

Vet. Rec. 1954, **66**, 385-6.

Bull semen was collected at the Cambridge Cattle Breeding Centre, diluted 1 : 24 in the presence of 10 per cent. glycerol, frozen, and transported by air to Onderstepoort Veterinary Research Laboratory, in South Africa, where it was stored in dry ice at -79°C.

Over a period of four and a half months 39 cows in two herds were inseminated with this semen. Seven of these cows were subsequently found to be sterile or to have very poor fertility.

Conception resulted in 23 cows, 19 holding after one insemination, three after two, and one after three inseminations.

The fertilising capacity of the semen was not impaired by all the handling and exposure involved and by the subsequent storage.

The first calf has now been born and appears perfectly normal.

OTHER PAPERS

HAMMOND, J. **Artificial Pregnancy.** *Esso Fmr.* 1954, **6** (3), 10.

HAMMOND, J. **Quality in Meat.** *Esso Fmr.* 1953, **5** (4), 9.

ROBERTSON, A. & ROWSON, L. E. A. **Frozen for Posterity.** *Fmr & Stk-Breed. Yearb.* 1954, 93-6.

CROP PESTS AND DISEASES

1221* DUNNING, R. A.

Beet Stem Eelworm : Some Results of Preliminary Work.

Brit. Sug. Beet Rev. 1954, **22**, 161-6.

Stem eelworm (*Ditylenchus dipsaci*) attacking sugar beet in the seedling stage, causing distortion and 'multiple-crown', was first recognised in the field in June 1953. It had previously only been known to cause crown canker in the autumn.

The nature of injury in both spring and autumn is described and illustrated, and a map shows the known extent of infestation in England and Wales. The possible sources of infestation and reasons for the 1953 attacks are discussed and a list is given of the plants attacked by this race of stem eelworm. The damage was assessed at two sites in 1953 and the overall loss from stem eelworm attack in spring and autumn at the levels observed was estimated as £4 to £5 per acre.

1217* JONES, F. G. W.

Beet Eelworm in England and Wales.

Rapp. Inst. Int. Rech. Betteravières. 16th Assemblée, Bruxelles, 1953, 105-8.

Z. Zuckerind. 1954, **8**, 341-2.

Beet eelworm is widely scattered in England and is known to occur also in Wales, Scotland and Ireland. A brief account is given of the measures adopted for its control in the most seriously affected areas in England which lie in the Fenlands. An outline of research in progress on the eelworm is also given.

JONES, F. G. W.

Differentiation of Species of *Heterodera*.

Proc. Int. Nematol. Symp. F.A.O., 1952, 52-5.

The cysts of different species of *Heterodera* were compared. When still attached to the host root an egg sac may be present containing variable numbers of eggs, according to which the species may be arranged in series from *H. carotae* and *H. cruciferae* with large egg sacs containing many eggs to *H. rostochiensis* which has no egg sac. Cysts free in the soil are difficult to identify. Measurements of length and breadth and length/breadth ratios are of little use. Colour also is rather variable. There are differences in cyst wall patterns and in the shape of eggs. There is a need for further microscopical study of these and of certain morphological characters of larvae in order to facilitate the separation of species on definite morphological grounds.

1209* JONES, F. G. W.

First Steps in Breeding for Resistance to Potato Root Eelworm.

Ann. Appl. Biol. 1954, **41**, 348-52.

The origin and progress of breeding for resistance is briefly reviewed and an account is given of preliminary work in progress at Cambridge. All the resistant plants tested so far are invaded by eelworm larvae. Some males complete their development but, except very occasionally, the development of females is arrested before the cystic stage is reached. Resistant plants of *Solanum andigenum* produced an active root diffusate. Diffusates from *S. vernei* and *S. vernei* × *S. stenotomum* were less active. Resistant plants reduced the eelworm content of infested soil in which they were grown and might therefore be used as trap crops.

1205* JONES, F. G. W. & DUNNING, R. A.

The Control of Mangold Fly (*Pegomyia betae* Curtis) with D.D.T. and other Chlorinated Hydrocarbons.

Ann. Appl. Biol. 1954, **41**, 132-54.

Laboratory and field trials were carried out in the period 1948-52 with D.D.T., B.H.C., and other chlorinated hydrocarbon insecticides and with parathion for the control of mangold-fly larvae (*Pegomyia betae* Curtis) mining in the leaves of sugar beet. Kills ranging from 85 to 99% were obtained within 6 days with 'high'- and 'low-volume' sprays using 6-24 oz. of D.D.T. per acre in the form of an oil emulsion applied as a top cover only. Formulation in oil improved the action of the D.D.T., it being necessary to use dusts and wettable powders at excessive rates to obtain equivalent kills. D.D.T. was usually superior to B.H.C. when compared at customary rates of application for both insecticides. When oil emulsions were compared side by side, however, as 'low-volume' sprays, D.D.T. was not significantly better than B.H.C. In the same trial, toxaphene, aldrin and dieldrin also gave kills of the same order as B.H.C. and D.D.T. With the possible exception of parathion, none of the insecticides used appeared to have any effect upon eggs.

Plot yields of two of the trials were determined in the autumn, but only at one trial was there a significant increase in yield on the treated plots. At this trial the mangold-fly infestation was severe, there being twenty-five unhatched eggs and twenty larvae per plant at the time of treatment. Attempts were made to assess the degree of defoliation and to relate it to larval population and to the effect on yield.

Commercial insecticides of the 'stock emulsion' and 'miscible oil' types occasionally caused phytotoxicity when applied to sugar beet at excessive, 'high-volume' rates and concentrations. More serious phytotoxicity was observed in tests of commercial insecticides used at 'low-volume' rates and concentrations. Out of ten products tested, only three were acceptable over the whole range of rates and concentrations employed, whilst four caused injury over the whole range.

The results obtained in the field and the laboratory were in agreement but did not always agree with the findings of other workers. B.H.C. has previously been recommended largely on the basis of experiments on larvae mining very small beet plants when in, or just beyond the cotyledon stage. All the trials by the authors were on sugar-beet seedlings with about six foliage leaves and normal in size for the time of year. On these plants B.H.C. proved ineffective both as dust and 'high-volume' spray when used at customary rates, but was effective as a 'low-volume' spray in oil emulsion.

The successful control of mining larvae by D.D.T. and other chlorinated hydrocarbons is probably due to penetration of the leaf tissue by the insecticide.

1199* WALLACE, H. R.

Hydrostatic Pressure Deficiency and the Emergence of Larvae from Cysts of the Beet Eelworm.

Nature, Lond. 1954, **173**, 502-3.

The relationship between hydrostatic pressure deficiency in sand and the number of larvae emerging from cysts of the beet eelworm (*Heterodera schachtii*) was investigated. The optimum rate of larval emergence corresponded approximately to the pressure deficiency at which the last pore space was emptied of water. It was suggested that the relatively low emergence rate at low pressure deficiencies was due to the reduced oxygen concentration in the water around the cysts when the sand was saturated and the pore spaces filled with water. An increase in the emergence rate occurred when air appeared in the pore spaces. The subsequent decline in emergence at higher pressure deficiencies was attributed to either extraction of water from the cysts or impeding of larval emergence by the surface forces of the water film.

OTHER PAPERS

JONES, F. G. W. **The Assessment of Injury to Sugar Beet Caused by Seedling Pests of Sugar Beet.** *Brit. Sug. Beet Rev.* 1954, **22**, 109-12.

PLANT BREEDING AND GENETICS

HOWARD, H. W.

Crops and Plant Breeding.

J. R. Agric. Soc. 1953, **114**, 90–106.

The headings in this annual review are :—Barley, varieties of malting barley, Proctor—a new variety of malting barley, X-ray mutations ; Wheat, breeding methods, yellow rust, soil-borne diseases, inter-generic and inter-specific hybrids, varieties ; Oats, variety trials, kernel content ; Sugar Beet, variety trials, tetraploids, virus yellows ; Potatoes, varieties and diseases, blight, virus diseases, dry rot, gangrene, root eelworm resistance, new variety—Pentland Ace ; Herbage Plants, polycross test, perennial ryegrass, seeds mixtures ; Beans ; Selective Weed Control, in fibre flax crops, damage to cereals ; and Systemic Fungicides.

1228* HOWARD, H. W.

Induced and Natural Polyploidy in *Nasturtium* and *Rorippa*.

Proc. 7th Int. Bot. Congr., Stockholm, 1950, 331–2 (Abstr.). Issued 1953.

Three aspects of the work on the naturally occurring tetraploid form of watercress are discussed. They are firstly, the method of showing that it is an allotetraploid by crossing it with a colchicine-produced autotetraploid of diploid watercress, secondly, its "physiology" which approaches that of a diploid rather than that of an artificially-produced tetraploid, and thirdly, its nomenclature. Diploid and tetraploid forms have also been found in two species of *Rorippa*.

1187* HOWARD, H. W. & SWAMINATHAN, M. S.

The Cytology of Haploid Plants of *Solanum demissum*.

Genetica. 1953, **26**, 381–91.

Plants with a chromosome number of $2n=36$ were obtained from crosses of *S. demissum* ($2n=72$) female $\times$ diploid species ($2n=24$).

The plants with $2n=36$ appeared morphologically to be haploid *S. demissum* plants.

One plant formed an average of 6.59 bivalents per nucleus, and another plant 9.78 bivalents per nucleus. A single trivalent was seen in 2 cells out of a total of 160 examined in the second plant.

By colchicine treatment a sector with doubled chromosome number was produced on one of the 36-chromosome plants. Flowers on this doubled sector were fertile and were crossed with normal *S. demissum*.

The offspring from these crosses resembled normal *S. demissum*, formed 36 bivalents at first metaphase, and were fully fertile.

It is, therefore, concluded that the 36-chromosome plants are true haploids of *S. demissum*, and that they do not contain a mixture of *S. demissum* and the diploid species chromosomes as suggested by Koopmans (*Genetica*. 1951, **25**, 193).

1191* PERRING, F. H.

A 17th Century Contribution to the Scottish Flora.

Watsonia. 1953, **3**, 36–40.

Martin Martin's book *A Description of the Western Islands of Scotland* contains many plant records made at the end of the 17th Century which appear to have been overlooked. For this reason the plant names were extracted and listed according to the island on which Martin said they grew. In most cases the names were in English or Scots but as far as possible a Latin name has been given.

The most important record is the first known for Great Britain of *Dryas octopetala*. It was found in Ireland in 1650 by Heaton. Martin's reference to it growing on Ben Suardal 3 miles S.W. of Broadford, Skye (where it was recorded subsequently in 1776 and 1916), precedes by 21 years the note in the 3rd edition of Ray's Synopsis edited by Dillenius and published in 1724, which said that it was abundant over all the high mountains of Scotland.

SWAMINATHAN, M. S. & HOWARD, H. W.

The Cytology and Genetics of the Potato (*Solanum tuberosum*) and Related Species.

Bibliogr. Genet. 1953, **16**, 1–192. (Obtainable from Martinus Nijhoff, The Hague, Price 18 Guilders.)

A comprehensive review of literature on cytology and genetics of potatoes from 1925 to 1952. Reference is made to work before 1925, the last time when potato cytology and genetics were adequately reviewed, in cases where it is necessary. Genetics is interpreted in a wide sense, and special emphasis is given to the problems of inheritance of resistance to diseases and pests.

OTHER PAPERS

BELL, G. D. H. *Agricultural Crops : Quality versus Quantity*. *Nature, Lond.* 1954, **173**, 198.

BELL, G. D. H. *The History of Cereal Cultivation (Pt. II)*. *Ass. Agric. Rev.* 1953 (21), 4–16.

BELL, G. D. H. *Polyploidy and Plant Breeding*. *N.A.A.S. Quart. Rev.* 1953 (22), 47–54.

SOIL SCIENCE

1203* ARNOLD, P. W.

Losses of Nitrous Oxide from Soil.

J. Soil Sci. 1954, 5, 116-28.

Data obtained from infra-red spectra of soil airs collected both in laboratory experiments and in the field indicate that nitrous-oxide evolution is a factor of considerable significance to the nitrogen economy of soils.

Soils which are approaching saturation with moisture rapidly release large amounts of their available nitrogen as nitrous oxide; at lower moisture contents very slow evolution of the gas can take place.

The soils of the earth are shown to be a very possible source of supply of atmospheric nitrous-oxide.

1174* COLLIS-GEORGE, N.

Relationship Between Air and Water Permeabilities in Porous Media.

Soil Sci. 1953, 76, 238-50.

The theory of Childs and Collis-George for calculation of permeability at all moisture contents from the pore size distribution of a soil is adapted for calculation of water and air permeabilities in unsaturated media from the moisture characteristic.

An experiment for the simultaneous measurement of air and water permeabilities in an equilibrium state is described for unsaturated unconsolidated isotropic media. The agreement between experiment and theory is satisfactory.

Air permeabilities are always greater than water permeabilities at the same fluid porosity.

The influence of permeability on air diffusion is discussed.

1193* NICHOLSON, H. H.

Control of Ground Water Level in Crop Production.

Rep. 13th Int. Hort. Congr. 1952, 2, 904-12.

Much valuable agricultural land has been obtained by lowering the ground water level in swampy areas. Is there an optimum ground water level for the purposes of agriculture? The history of the Fenland in Britain is outlined and a current experiment on the control of ground water level is described. Three years experience with the celery crop has shown that benefit can be obtained from static ground water levels as high as 20 inches but that in moist summers both yield and quality are depressed by levels higher than 20-24 inches. The celery crop is planted here in early June when normally a moisture deficit is appearing in the soil. The magnitude and time of incidence of this deficit are conditioned by the rainfall sequence of June-September inclusive and can be modified by the control of the ground water. Thus, in a dry summer, a high ground water level gives optimum moisture conditions and a low level gives full play to the limiting influence of an increasing deficit of moisture in the soil. In moist summers this is mitigated to the advantage of the crop above a low water level, but in the presence of a high ground water, water-logging may result from the same rainfall, to the disadvantage of the crop.

1206* RIDER, N. E.

Eddy Diffusion of Momentum, Water Vapour, and Heat Near the Ground.

Phil. Trans. 'A'. 1954, 246, 481-501.

An account is given of an experimental study of the factors which control the vertical turbulent transport of momentum, water vapour, and heat in the first 2 m. of air above a short grass surface. The results of fifty-one observations, each of which extended over 30 mins., are presented. Measurements were made of the vertical profiles of wind speed, temperature and humidity, and of the rate of evaporation and the aerodynamic drag of surface. Measurement of the heat-balance components was also attempted. On any one occasion it was not generally possible to observe all the desired quantities.

It is found that the wind speed and temperature profiles always have the same form, and that this form is shared on the majority of occasions by the humidity profile. The profiles depart from the logarithmic form found in adiabatic conditions in the manner suggested by Deacon. In near adiabatic conditions as defined by small numerical values of the Richardson number the established laboratory law relating the surface drag to the fluid velocity over a rough surface in turbulent flow is found to hold over the site and a value is deduced for von Kármán's constant. In conditions other than adiabatic it is shown that the explicit wind profile law suggested by Deacon holds in unstable but not in stable conditions. In the latter conditions equations proposed by Rossby & Montgomery and by Holtzman are found to represent the observations with reasonable precision. The friction coefficient of the surface is computed and found to be independent of wind speed but to increase in value in unstable conditions. Values of the eddy diffusivity for momentum, water vapour and heat are obtained on a direct observational basis from the expressions from which the diffusivities are normally defined, and it is found that the diffusivities for momentum and vapour are identical over the range of stability experienced. The magnitude of the diffusivity for heat often appears to be approximately the same as that for momentum or vapour, but exceptions occur when it is much larger than the other two. The exceptions do not appear to be related to stability.

1207* RIDER, N. E.

Evaporation from an Oat Field.

Quart. J. R. Met. Soc. 1954, **80**, 198–211.

Evaporation from natural surfaces may be evaluated by a method based on aerodynamic considerations which lead to the simple equation

$$E = \frac{\rho k^2 (u_2 - u_1) (q_1 - q_2)}{\left[\ln \left(\frac{z_2 - d}{z_1 - d} \right) \right]^2}$$

in which E , ρ and k are the rate of evaporation, the air density and von Kármán's constant respectively, u_1 , u_2 , q_1 and q_2 are the wind speeds and specific humidities at the heights z_1 and z_2 , and d the so-called surface zero displacement. This formula has been applied to observations taken over an oat field in order to determine the hourly values of E during a number of periods ranging in length from one to twelve days. The magnitude of d is shown to increase with increasing crop height and wind speed, the crop height increasing eightfold over the total period of observation. Daily water losses are calculated and found to vary from 0.05 mm. to 5.65 mm. By using two sets of apparatus, the calculated values of E are shown, in unstable conditions, to depend on the height of exposure of the apparatus, decreasing with increasing height. A modified form of the equation, based on Deacon's generalised wind-profile law, has been used in the last period of observation and found to reduce the dependence of the calculated values of E on the level at which the apparatus was placed. The general application of the modified expression was found to be impossible owing to insufficient precision in the measurements of the wind speeds and to the uncertainty in the value to be assigned to d . In general, the computed daily water losses are considered to be underestimated to an extent not exceeding 15 per cent.

STATISTICS

1226* WISHART, J. & METAKIDES, T.

Orthogonal Polynomial Fitting.

Biometrika. 1954, **40**, 361–9.

There are considerable advantages to be gained by using orthogonal polynomials when fitting curves to data by the method of least squares. The computer whose data are equally spaced, and of equal weight, is well catered for by tables, the best known of which are due to Fisher & Yates. In the general case of unequally spaced and weighted data similar tables are impracticable; what the computer needs is a good calculation scheme, so designed that it makes little appeal to the memory, or the mathematics, and is as far as possible self-checking. There is only one mathematical basis for the methods, but a number of computing techniques have been devised, chiefly in order to carry out the inversion of the matrix whose elements are the equivalent of the variance and covariance estimates in the parallel problem of multiple regression.

The purpose of the present paper is to supplement the recently published *Biometrika Tables for Statisticians* by offering a single recommended computation scheme for the general case. Like some other schemes, it is set out in tabular or 'blank' form, for ease of general manipulation. It is approached through multiple regression analysis, and to stress this fact the standard regression notation has been used. The arrangement is such that everything that can possibly be wanted is obtained within the tabular scheme. One point which may be considered convenient, e.g. for plotting purposes, is that while the orthogonal polynomials are calculated, the result is also given at any stage as a simple polynomial. One of the authors has examined the alternative schemes in application to the illustrative example given later in the paper, and the conclusion is that the method and scheme now offered are the most convenient for use by the average computer.

MISCELLANEOUS

BUTTRESS, F. A.

World List of Abbreviations of Scientific, Technological and Commercial Organizations.

Pp. ix+261. (Leonard Hill, London, 1954. 18s.)

Definitions of over 2500 abbreviations of professional, scientific and commercial bodies from all over the world are given in this work. Foreign abbreviations have been freely translated, and in the majority of cases, full postal addresses have been given.

ENGLEDOW, F. L.

The Food Manufacturer's Attitude to Science.

Food Sci. Abstr. 1953, **25**, 621–2.

BOOKS RECEIVED

THE LIBRARIAN HAS PLEASURE IN BRINGING THE FOLLOWING WORKS TO THE READER'S NOTICE

- BARNETT, A. J. G. **Silage Fermentation**. Pp. x+208, with 52 Figs and 55 Tables. (Butterworths Scient. Publ., London, 1954. 27s. 6d.). (American ed. by Academic Press Inc., New York).
- BENEDICT, M. R. **Farm Policies of the United States, 1790-1950**. Pp. xv+548. (Twentieth Century Fund, New York, 1953. \$5).
- BLOOM, A. **The Fens**. Pp. xii+325 with 25 illus. and Map. (R. Hall, London, 1953. 18s.)
- BOSTON, E. J. (Ed.). **Jersey Cattle**. Pp. 232, with 45 Figs, 76 Plates and Appendices. (Faber and Faber, London, 1954. 42s.)
- BOURNE, G. H. & KIDDER, G. W. (Ed.). **Biochemistry and Physiology of Nutrition**. Vol. 2. Pp. xii+641. (Academic Press Inc., New York, 1953. \$15)
- BRADFORD, L. A. & JOHNSON, G. L. **Farm Management Analysis**. Pp. xii+438, with many Figs and Tables. (Wiley [Chapman & Hall, London], 1953. 46s.)
- CARLSON, A. J. & JOHNSON, V. **The Machinery of the Body**. 4th ed. Pp. xxi+663, with 223 Figs and 15 Tables. (Univ. Chicago Press [Cambridge Univ. Press, London], 1953. 41s. 6d.)
- DAVIDSON, H. R. **Production and Marketing of Pigs**. 2nd ed. Pp. xvi+537, with 96 Plates, 106 Tables and 46 Figs. (Longmans, Green & Co., London, 1953. 40s.)
- DE ONG, E. R. **Insect, Fungus and Weed Control**. Pp. 400, with 11 Tables and 37 Illus. (Thomas & Hudson, London, 1953. 52s. 6d.)
- ELLIS, J. C. B. **The Feeding of Farm Livestock**. 3rd ed. Pp. xv+267, with 6 Figs and 12 Plates. (Crosby Lockwood, London, 1954. 21s.)
- Farm Mechanization Directory, 1954**. Pp. vii+612, with many plates. (Temple Press, London, 1953. 21s.)
- Farmer and Stock-Breeder Year Book, 1954**. Pp. 396. (London. 10s. 6d.)
- F.B.I. Register of British Manufacturers, 1954**. 26th ed. Pp. 952. (Iliffe & Sons Ltd., London. 42s.)
- FISHWICK, V. C. **Pigs, Their Breeding, Feeding and Management**. 5th ed. Pp. 228, with 32 Plates, 2 Diagrams & 14 Plans. (Crosby Lockwood, London, 1953. 18s.)
- FRASER, A. **Beef Cattle Husbandry**. Pp. xii+244, with 56 illus. (Crosby Lockwood, London, 1953. 18s.)
- FRITSCH, F. E. & SALISBURY, Sir E. **Plant Form and Function**. New & rev. ed. Pp. viii+673, with 445 Figs. (Bell, London, 1953. 30s.)
- GRONDONA, L. St. C. **Commonwealth Stocktaking**. Pp. xxiv+389, with 22 Plates. (Butterworths Scient. Publ., London, 1953. 35s.)
- HALNAN, E. T. & GARNER, F. H. **Principles and Practice of Feeding Farm Animals**. 4th ed. Pp. viii+408, with 46 Tables & 8 Appendix Tables. (Longmans, Green & Co., London, 1953. 25s.)
- HEADY, E. O. & JENSEN, H. R. **Farm Management Economics**. Pp. x+645, with numerous Figs and Tables. (Prentice-Hall, New York, 1954. 67s. 6d.)
- HENDERSON, F. **Making Mechanised Farming Pay**. Pp. 214, with many illustrations. (Dairy Farmer (Books) Ltd., Ipswich, 1954. 21s.)
- HUBBARD, C. E. **Grasses** (Illustrated). Pp. xii+428. (Penguin Books, Harmondsworth, 1954. 3s. 6d.)
- JACKS, G. V. **Soil**. Pp. x+221, with 7 Figs and 10 Plates. (Nelson, London, 1954. 12s. 6d.)
- LUSCOMBE, J. **Making Money from Pigs**. Pp. 108, with 41 Figs. (Dairy Farmer (Books) Ltd., Ipswich. 12s. 6d.)
- MANN, T. **The Biochemistry of Semen**. Pp. xiv+240, with 7 Plates & 16 Figs. (Methuen, London, 1954. 16s.)
- MASSEE, A. M. **The Pests of Fruits and Hops**. 3rd ed. Pp. xvi+325, with 32 plates. (Crosby Lockwood, London, 1954. 25s.)
- McELROY, W. D. & GLASS B. **Copper Metabolism**. Pp. viii+443, with many Figs and Tables. (Johns Hopkins Press [Geoffrey Cumberlege, London], 1950. 48s.)
- NAJJAR, V. A. **Carbohydrate Metabolism**. Pp. x+134, with 3 tables and 33 Figs. (Johns Hopkins Press [Geoffrey Cumberlege, London], 1952. 32s.)
- PETERSON, W. E. & FIELD, A. M. **Dairy Farming**. Pp. viii+534 with numerous plates and 5 Appendix Tables. (Lippincott Co., London, 1953. 32s.)
- ROBINSON, F. A. **Antibiotics**. Pp. viii+132, with 14 Tables. (Pitman, London, 1953. 15s.)
- RUSSELL, K. **Principles of Dairy Farming**. Pp. 278, with numerous Plates and 7 Appendices. (Dairy Farmer (Books) Ltd, Ipswich, 25s.)
- STONIER, A. W. & HAGUE, D. C. **A Textbook of Economic Theory**. Pp. x+513 with 124 Figs. (Longmans, Green & Co., London, 1953. 25s.)
- THROWER, W. R. **The Dexter Cow and Cattle Keeping on a Small Scale**. Pp. 200, with 12 Plates, 17 Figs, and 4 Appendices. (Faber and Faber, London, 1954. 18s.)
- WALLACE, T. & MARTIN, J. T. (Ed.). **Insecticides and Colonial Agricultural Development**. 6th Symposium of the Colston Research Society. Pp. x+169. (Butterworths Scient. Publ., London, 1954. 30s.)
- WALSTON, H. D. **No More Bread?** Pp. 159, with 12 Tables. (Gollancz, London, 1954. 12s. 6d.)
- WINTERS, L. M. **Animal Breeding**. 5th ed. Pp. x+420, with 112 Figs and 55 Tables. (Wiley [Chapman and Hall, London], 1954. 46s.)
- WO OLDRIIDGE, W. R. **Farm Animals in Health and Disease**. Pp. xvi+463, with 28 Figs, 56 Plates and 18 Tables. (Crosby Lockwood, London, 1954. 30s.)
- WYLLIE, J. **Farming Records and Accounts**. Pp. xiv+310, with 19 Forms, 10 Tables, etc. (Butterworths Scient. Publ., London, 1953. 30s.)

LIBRARY LACUNAE

The Librarian would welcome gifts or offers of any of the following items :—

- Agricoltura delle Venezie.** Vol. 1, Nos. 1-2 ; 5, Nos. 1, 3.
- Agrártudomány.** 1950, Nos. 9, 12 ; 1951, No. 6.
- American Society of Animal Production.** Record of Proceedings. 1908-1926, 1929-30.
- Annales de l'Ecole Nat. d'Agric. de Grignon.** Ser. 3. Tome 2.
- Annales de l'Institut de Recherches Agron. de Roumanie.** Vol. 14.
- Annales des Épiphyties.** Vol. 12, No. 4 ; 14, No. 2.
- Archief v. Rubbercultuur.** Vol. 25. No. 6.
- Archiv d. Deutschen Landwirtschafts—Gesellschaft.** No. 9.
- Aslib Book List.** Vol. 1, No. 4 ; 6, No. 1 ; 7, No. 3.
- Bibliography of Agriculture.** Washington. Vols. 1-2.
- Biologe (Der).** Vol. 4. Nos. 1-4.
- Biological Bulletin.** Vol. 53. No. 1.
- Biological Symposia.** Vols. 2-3.
- Bragantia.** Vol. 5. No. 4.
- Bodenkunde u. Pflanzenernährung.** Vol. 34, Nos. 3-6 ; 35, Nos. 5-6 ; 36.
- Botaničeskii Žurnal, U.S.S.R.** Vols. 21-22.
- Botany and Zoology (Tokyo).** Vols. 8, No. 11 ; 9, Nos. 1, 8-12 ; 10, Nos. 1-12 ; 11, Nos. 1-12.
- Bull. American Soil Survey Assoc.** Nos. 1-5, 10-11.
- Bull. Soc. Scient. d'Hygiène Alimentaire.** Vol. 31. Nos. 1-3.
- Canada. Nat. Res. Council.** Bibliography on Soil Mechanics.
- Cytologia.** Vols. 10, No. 3 ; 11-13 ; 14, Nos. 1-2 + Fuji Memorial Vol.
- Current Science.** Vols. 21, Nos. 5-12 ;
- Econ. Proceedings Royal Dublin Society.** Vol. I. No. 6.
- Farm and Forest (Nigeria).** Vol. 2, Nos. 3-4 ; 3, Nos. 1-4 ; 4, Nos. 1-4 ; 5, Nos. 1-3.
- Farming in South Africa.** Vol. 2. No. 17.
- Fecondazione Artificiale.** Vol. 4, No. 6 ; 5, Nos. 8, 12.
- Genetics.** Vol. 4. pp. 95-204.
- Handbuch d. Bodenkunde.** Vols. 1-10.
- Handbuch d. Pflanzenzüchtung.** Nos. 10-26.
- Indian J. of Agricultural Economics.** Vol. 1, No. 1.
- Intern. Mitteilungen f. Bodenkunde.** Vols. 5, 8-11.
- Iowa Agric. Exp. Stat. Bull.** 240.
- L'Italia Agricola.** Vol. 70. Nos. 1-9 ; 75, No. 2.
- J. f. Landwirtschaft.** Vol. 88, 1942.
- J. of Physiology.** Vol. 101, No. 2 ; 104, No. 3 ; 107, No. 3 ; 121, No. 2 ; 122, No. 1.
- J. of the Agric. Assoc. of China.** Nos. 164, 176.
- J. of the College of Agriculture. Tokyo Univ.** Vol. 14, No. 6 ; 15, 1-2.
- J. of the South-Eastern Agric. College.** Nos. 1-2, 4-8, 11.
- J. of Heredity.** Vols. 1-4 ; 5, Nos. 1-7. (Vols. 1-4 issued as Amer. Breeders' Mag.)

J. Pomology and Hort. Science. Vol. 1. No. 1.
J. Royal Hort. Soc. Vol. 58.
Jute Abstracts. Vol. 7. No. 4.
Kartoffelbau. Vol. 1, No. 1.
Kühn Archiv. Vols. 6-8, 57, 59.
Kulturtechniker. Vol. 42, Nos. 9-12 ; 44, Nos. 5-6.
Lloydia. 12, No. 3.
Maatalous ja Koetoiminta. No. 5.
Mémoires de l'Acad. Polonais. Ser. B. No. 4.
Nachrichtenblatt f. d. Deutschen Pflanzenschutzdienst. Vol. 3, Nos. 1-4, 11-12.
Natural and Applied Science Bulletin (Philippines). Vol. 8, No. 3.
Norfolk Agric. Exp. Stat. Bull. Nos. 2-3.
North Dakota Bi-Monthly Bulletin. Vol. 2, No. 6.
Nova Acta Leopoldina. Vol. 10. No. 65.
Philippine J. Agric. Vol. 10 (Index) ; 12, No. 3.
Philippine J. Animal Husbandry. Vol. 8, Nos. 4-5.
Proc. Amer. Soc. Hort. Science. Vol. 53.
Proc. Crop Science Soc. Japan. Vol. 11, No. 4 ; 14, No. 2 ; 17, Nos. 2-3.
Proc. Inst. British Agric. Engineers. Vols. 1-2 ; 3, No. 7.
Proc. N.Z. Grassland Assoc. 11th, 12th.
Proc. N.Z. Soc. of Animal Production. 2nd, 4th, 9th.
Proc. Royal Society. B. Vol. 127, No. 847 ; 132, No. 866 ; 134, No. 874 ; 137, No. 889.
Publicatie v. Comm. v. h. Kunstmatig Drogen v. Gras. Nos. 4, 6.
Revista Agronomica, Lisbon. Vol. 35, No. 1.
Risicoltura (Vercelli). Vol. 32. Nos. 7-9.
Rivista di Zootechnia (Firenze). Vol. 18, Nos. 11-12 ; 19, Nos. 1-2.
Scientific Agriculture. Vols. 1-7.
Sveriges Pomologiska Förenings Årsskrift. 1942, 1943.
Trans. Amer. Assoc. Cereal Chemists. Vol. 1, Nos. 1-2 ; 2, Nos. 2, 4.
U.S. Bur. of Soils. Bull. 45 (1907).
U.S. Dept. Agric. Circ. 524, 525 ; **Technical Bull.** 336, 428.
Věstník Česk. Akad. Zemědělské. Vol. 15. Nos. 1-2.
Welsh Plant Breeding Station. Bulletin. Ser. H. No. 1.
Z. f. Induktive Abstammungs— u. Vererbungslehre. Vol. 77, Nos. 2-4 ; 78, Nos. 1-4 ; 79, Nos. 2-3.
Z. f. Pflanzenbau u. Pflanzenschutz. Vol. 3, No. 2.
Z. f. Tierzüchtung u. Züchtungsbiologie. Vol. 48, No. 3.
Züchtungskunde. Vol. 14, Nos. 9-11 ; 19, Nos. 9-12.

AUTHOR INDEX

- Adams, C. E., 19
Arnold, P. W., 23

Baldwin, G. C., 12
Barnard, C. S., 12
Bell, G. D. H., 22
Bishop, M. W. H., 15-16, 19
Brochart, M., 19
Brookes, A. J., 12
Buttress, F. A., 24

Campbell, R. C., 15-16, 19
Clarke, G. B., 12
Clayton, E. S., 12
Collis-George, N., 23
Comline, R. S., 16

Dott, H. M., 16, 19
Dudley, F., 13
Dunning, R. A., 20-21

Edgar, D. G., 16
Edwards, J., 19
Engledow, F. L., 12, 24
Evans, R. E., 13-14

Farm Economics Branch, 11

Glover, T., 17

Hammond, J., 13, 17-20
Hancock, J. L., 15-16, 19
Hanley, F., 12
Howard, H. W., 22
Hunter, G. L., 18

Jones, F. G. W., 20-21
Joubert, D. M., 13-15

Lutwak-Mann, C., 18
Lamming, G. E., 15
Lawson, M. R., 15
Lewis, P. R., 18

Mackness, R. A., 12
Mann, T., 17
Mansfield, W. S., 5-10, 12
Maqsood, M., 18-19
Marden, W. G. R., 19
Metakides, T., 24
Millen, J. W., 15
Murdock, M. I., 20

Nicholson, H. H., 23
Nix, J. S., 12

Pease, M. S., 13
Perring, F. H., 22
Polge, C., 20
Pomeroy, R. W., 16

Rider, N. E., 23-24
Robertson, A., 20
Rowson, L. E. A., 15, 20

Sturrock, F. G., 12
Swaminathan, M. S., 22

Titcher, D. A., 16

Van Rensburg, S. W. J., 20

Wallace, D. B., 12
Wallace, H. R., 21
Walton, A., 15-16, 19
Wishart, J., 24
Woollam, D. H. M., 15

PUBLICATIONS

Agricultural Periodicals of the British Isles, 1681-1900, and their Location. Compiled by F. A. BUTTRESS. Price 2s.

Handbook to the School of Agriculture, containing full information as to the Ordinances governing the teaching, examinations and other activities of the School of Agriculture; and in addition general information concerning the study of Agriculture at Cambridge. Price 2s. 6d.

School of Agriculture Memoirs

Nos. 1-10. Price 1s. 2d. each. Post Free. (*Nos. 1-3, 6, 10 out of print*).

Nos. 11-12. Price 2s.

Nos. 13-14. Price 6d.

Nos. 15-17. Price 3s.

Nos. 18-20. Price 2s. each.

Nos. 21-25. Price 2s. 6d. each. (*No. 24 out of print*).

All the above are obtainable from the Secretary, School of Agriculture, Cambridge.

For publications of the Cambridge University Agricultural Society and other organisations associated with the School of Agriculture applications should be made as follows :

Cambridge University Agricultural Society

The Secretary, C.U.A.S., School of Agriculture, Cambridge, England.

Commonwealth Bureau of Plant Breeding and Genetics

The Director, Commonwealth Bureau of Plant Breeding and Genetics, School of Agriculture, Cambridge, England.

Provincial Agricultural Economics Service

The Secretary, Provincial Agricultural Economics Service, School of Agriculture, Cambridge, England.